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TRANSPORTATION AND SERVICE MEETINGS NUMBER

SOCIETY OF AUTOMOTIVE ENGINEERS INC.
29 WEST 39TH STREET NEW YORK

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H. L. HORNING, *President* COKER F. CLARKSON, *Secretary* C. B. WHITTELSEY, *Treasurer*

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THE JOURNAL OF THE SOCIETY OF AUTOMOTIVE ENGINEERS

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Chronicle and Comment

Carnival Plans Mature

AT least 1000 members and guests of the Society will find enjoyment on the evening of Jan. 27, during Annual Meeting week, in the Carnival that is being arranged under the guidance of Walter R. Flannery and his committee of experts in staging events of this character. Following the practice of former years this colorful and entertaining event will take place at Oriole Terrace, and it is anticipated that the attractiveness of its many features will make a strong appeal to our membership.

Annual Dinner, Jan. 14

CHAIRMAN W. L. BATT of the Annual Dinner Committee expects soon to have a very interesting announcement to make regarding the features of the Annual Dinner, a classic among Society events, that will be held this year on Jan. 14 during Show Week at the Hotel Astor, New York City. It behooves all Society members to watch for developments in this connection and to make a definite reservation of Jan. 14 for the enjoyment of an affair that will arouse an appeal to the many senses.

An Interesting Section Plan

EVERY Tuesday noon the Northern California Section holds an informal luncheon at the Engineers Club in San Francisco, at which definitely announced engineering topics are discussed. This is in addition to the regular monthly technical meetings. On Nov. 17, for example, the topic of chassis lubrication was treated in an informal way, whereas cylinder refinishing was the topic of greatest interest at the Nov. 24 luncheon.

Many points can be urged in favor of this plan, and it should be interesting for other Sections to watch the success of the Pacific Coast members in carrying it out.

The Service Engineering Meeting

PREVENTIVE maintenance methods were the subject of extensive consideration at the Service Engineering Meeting held by the Society in cooperation with the National Automobile Chamber of Commerce at Hotel LaSalle, Chicago, on Nov. 9 and 10. Active participation of many of those present in the discussion of the papers indicated that the meeting was worthwhile and that it provided a desirable opportunity for the interchange of ideas on maintenance topics. Several of the papers and a news account of the Service Engineering Meeting are presented elsewhere in this issue of THE JOURNAL.

Publicity with a Punch

JUDGING from the attractiveness of the advance notices of meetings that are prepared by various Sections, those responsible for the success of Section meetings are fully aware of the effectiveness of attractive and lively publicity. Whether the Section adopts the Junior Journal booklet idea that is utilized by the Detroit and the Cleveland Sections is beside the point. The objective should be to tell the story of the features of the coming meeting in an accurate but palatable manner. The officers of all Sections will find it worthwhile to study the methods that have proved to be most helpful in other Sections.

Annual Meeting, Jan. 26 to 29

A BIGGER and better Annual Meeting is promised for Jan. 26 to 29 inclusive at the General Motors Building, Detroit. The Meetings Committee has been successful this year in arranging an extremely attractive program that will fully occupy a larger number of Sessions than have ordinarily been held at an Annual Meeting. Over a dozen different major topics will be thoroughly discussed and much new thought along various lines will be developed.

Further announcements regarding the Annual Meeting will appear in the pages of THE JOURNAL and in the *Meetings Bulletins*.

The Motor Vehicle and the Railroad

AT the Transportation Meeting last month, President Vauclain, of the Baldwin Locomotive Works, said that no industry in the United States can survive if it ignores the youthful endeavor of the rising generation. As a man closely identified with the railroad business and a leader for many years in the development of rolling-stock for rails, he recorded his conviction of the complementary nature of the railroad and the motor vehicle, as opposed to the competition between them. A. F. Masury, toastmaster for the diners whom Mr.

Vauclain addressed, related the support and very helpful assistance that Mr. Vauclain had rendered the motor-truck industry in its early days. In his address Mr. Vauclain advocated that the surface of streets in general be used exclusively for motor-vehicle traffic.

What Did Pennsylvania Do?

AMONG the most pleasing features of the Automotive Transportation Meeting was the active cooperation of the Pennsylvania Section, the members of which assisted materially in making arrangements for the Meeting and in conducting it. Ofttimes committees have been known to exist in name only but this was decidedly not the case in Philadelphia.

A courteous gesture on the part of the Pennsylvania Section was the presentation to each of those who attended the meeting of a leather bound notebook.

Among those whose assistance materially lightened the burdens of the main committee were F. L. Berger, R. W. A. Brewer, A. K. Brumbaugh, E. L. Clark, E. A. Corbin, A. Gelpke, G. Walker Gilmer, R. H. Horton, H. S. Meese, A. G. Metz and R. R. Whittingham.

Motorcoach Battery Standards

THE action of the Storage-Battery Division at Philadelphia during the Transportation Session in proposing for adoption as S.A.E. Standard seven sizes of storage-batteries for motorcoach service should be welcomed by the motorcoach industry.

The survey of present practice upon which the Division recommendation is based indicates that more than 75 sizes of battery are being made for motorcoach service. When it is appreciated that only seven sizes of storage-battery are required by the passenger-car industry, there seems to be no reason why the motorcoach industry, practically a new industry, should not profit by the experiences of passenger-car builders.

The requirements of motorcoach service being decidedly different from passenger-car or motor-truck service, special battery sizes are recommended by the Storage-Battery Division. A special rating, based on an 8-hr. discharge period, was adopted also in recognition of the special requirements of motorcoach service. Complete information in connection with the Storage-Battery Division action is given in detail on p. 541 of this issue.

Transportation Meeting Breaks Record

NOV. 13 and 14 were days crowded with interest for those engineers who were able to attend the Society's Automotive Transportation Meeting in Philadelphia. The program comprised three technical sessions devoted respectively to standardization, freight handling and motorcoach operation, a banquet at the Benjamin Franklin Hotel and an inspection visit to the maintenance plant of the Philadelphia Rural Transit Co. Each of these features attracted a large attendance of those who represent the many branches of the automotive transportation field.

The attendance this year of 325 exceeded that at last year's Automotive Transportation Meeting by approximately 125. The attendance at the banquet equaled the total registration for the entire meeting.

Judging from many comments that were made by members and guests, Chairman A. W. S. Herrington and his committee that included C. O. Guernsey, F. C. Horner, A. E. Hutt, A. F. Masury, R. E. Plimpton and E. W. Templin, should feel well satisfied with the success of their undertaking. The Society's membership owes this committee a debt of gratitude for its excellent work.

S.A.E. Handbook To Be Issued as Bound Volume

A COMPLETE volume of the S.A.E. Standards and Recommended Practices, bound in limp imitation-leather, will be sent to the members in March, 1926, in place of the usual issue of new and superseding data sheets. Subsequent volumes will appear semi-annually.

The number of loose-leaf sheets in the S.A.E. HANDBOOK has increased to such an extent that it would be necessary soon for the members to split the volume into two parts and purchase an additional binder if the other form of binding were not adopted. Another good feature of the bound volume is that it will eliminate the necessity for inserting new sheets as they are issued. This has been a source of bother to a great many of the members. With the issues of the complete volume in bound form the members will have uptodate Handbooks in their hands at all times.

The new form of volume will be sewn so that the book will lie flat when open. Thinner paper will be used for the text pages and the new volume will be considerably less bulky than the present loose-leaf volume. The page size will be the same, but the over-all dimensions of the book will be 4½ x 7½ in., a convenient size for the pocket.

The increased cost of the bound volume will be met by the inclusion therein of advertising of a nature that will assist the users of the S.A.E. HANDBOOK in locating sources of supply for parts, accessories and materials conforming to or incorporating S.A.E. Standards and Recommended Practices.

The National Automobile Shows

OFFICIAL figures show that models of 50 makes of passenger car will be on display in Grand Central Palace, New York City, during the week of Jan. 9 to 16, and 1 less make at the Coliseum in Chicago, Jan. 30 to Feb. 6. In addition, eight makes of taxicab will be on exhibition at each Show. According to present reports, the accessory division of the New York Show will have exhibits of the products of 156 accessory and parts manufacturers. The Chicago Show will have a total of 117 such exhibits.

The National Automobile Chamber of Commerce, as sponsor for both the New York and the Chicago Shows, is giving particular attention to the trade periods of the Shows. The phase of trade activity at the Shows is becoming more and more important. Much of the buying for next year's production will be negotiated for at the Shows.

This year the trade periods will be from 10 a. m. to 1 p. m. on each Monday and Tuesday and during the periods the factory representatives and dealers will be at liberty to inspect everything and discuss business matters without interruption.

The Shows provide excellent opportunity for the engineer to furnish and receive information. Comparisons with the product of others create a healthy discontent and the desire for improvement of one's own product. The material man, parts maker, manufacturer, dealer, salesman, engineer and retail customer meet at the Shows to exchange ideas for mutual benefit. The latest developments in accessories are available for inspection. The engineers give of their knowledge to the public, greatly to the advantage of the latter, and in turn necessarily to the advantage of the industry. The members are urged to increase the engineering interest at the Shows. This can be done best by increased attendance at the exhibit booths of men qualified to discuss technically the points involved in vehicles, parts and accessories.

Photo by N. Lazarnick, Official Automotive Transportation Meeting Photographer

PREVENTIVE METHODS PRESCRIBED

Service Engineers Advocate Wider Adoption of Chinese Doctoring in Motordom

"An ounce of prevention is worth a pound of cure" in the automotive industry as well as in medical fields, if one can judge by the remarks of the speakers at the Service Engineering Meeting, sponsored jointly by the Society and the National Automobile Chamber of Commerce, and held Nov. 9 and 10 at the Hotel LaSalle, Chicago. This time-worn adage and other parallels were often referred to as the needs and methods for improved automobile maintenance were stressed; in fact the application of preventive measures might well have been considered as the text of the four sessions of the Service Engineering Meeting.

Among the topics discussed by men prominent in the field of automobile maintenance were Corrosion, Diagnosis of Troubles and Their Cure, Automotive Fuels, Tool Equipment, and Devices for Improving Car Operation. The discussion of these topics was extensive and to the point, and it is felt that those who attended the meeting, approximately 200 in number, derived from it benefits that fully repaid them.

The opening and closing sessions, respectively under the chairmanship of A. B. Cumner, of the Autocar Co., and F. J. Wells, of the Pierce-Arrow Motor Car Co., were sponsored by the National Automobile Chamber of Commerce; whereas the intervening sessions, under the chairmanship respectively of H. L. Horning, of the Waukesha Motor Co., and L. H. Pomeroy, of the Aluminum Co. of America, were under the auspices of the Society.

Zimmerman Welcomes Members

In the words of O. B. Zimmerman, of the International Harvester Co., and second vice-president of the Society representing tractor engineering, who made the address of welcome at the opening session of the Service Engineering Meeting

> Service may be defined as those activities of the manufacturer which tend to lessen the buyers' difficulties in the operation of his product, in maintaining that operation and in extending the satisfactory use of the purchase.

The speaker stated that any marketed product reaches a standard economic basis only when its entry into our national life results in benefits that are secured at a warranted and reasonable cost. Mr. Zimmerman, representing the farm implement industry, dwelt briefly upon the influences that have extended from this industry to activities in the automobile field. He stated that the "let the buyer beware" attitude has been, and always will be, a sure indication of the failure of those who apply it.

In concluding his remarks, Mr. Zimmerman commended the spirit of mutual helpfulness of man to man that exists in this country as nowhere else, and that is responsible, in a large measure, for the phenomenal success of American industrial enterprises.

Selling Transportation, not Cars

G. F. Lord, of the Durant Motors, Inc., in his address at the opening session entitled Automotive Transportation Preventive Service, said

> We are not merely in the business of manufacturing and selling a set of wheels moved by a gasoline motor—we are in the transportation business.

Continuing he said

> One of the most extravagant habits of the American people today is the carelessness with which they treat

L. H. Pomeroy

O. B. Zimmerman

this finely built piece of machinery, with resultant rapid deterioration both in utility and value.

Calling attention to the fact that well-built automobiles of today should be serviceable for at least 6 years, the speaker decried the practices, economically unsound, that result in economic losses and that consequently should not be endured. It was believed that the useful life of cars should be extended by both the builder and the user and in this connection a comparison was drawn between automotive practices and those of other pursuits. The life insurance companies, for example, find it profitable to expend large sums in advertising and education, with a view to prolonging the life of policy-holders, thus extending the period during which premiums may be paid. In the dental profession, the newer practices call for the treatment and maintenance of teeth rather than their summary extraction.

In this connection Mr. Lord said

> All possible steps should be taken to encourage automobile owners to treat their transportation equipment as they treat their teeth, thus assuring uninterrupted operation and greater utility of the product.
>
> Advertising and salesmanship can put a man into a car, but cannot keep him there. Thus the automobile manufacturer and dealer organizations must in the future depend more upon their ability to maintain their transportation medium in efficient, economical operation, than on any other one factor. This involves, among other items, the establishment of proper maintenance facilities and the successful selling of the idea to the dealer element. Satisfactory maintenance opens the best source of new customers that can be obtained.

G. F. Lord

J. W. Lord

Periodical Inspection Sold with Car

In concluding his remarks, Mr. Lord mentioned the so-called maintenance plan under which the dealer, when selling a new car, also arranges with his customer for periodical and systematic preventive service to keep down the repair costs, and to increase the efficiency and length of life of the vehicle. He advocated the wider adoption of this system and spoke favorably of the adoption of flat rates in service-stations.

Repair Men's Tool Equipment Discussed

In recent years automotive engineers have devoted more attention than in the early days to factors such as accessibility and serviceability that are so important in the maintenance of a vehicle.

At the opening session, D. C. Hinckley, Hinckley-Myers Co., in his paper Designing with Consideration for Repair Men's Tool Equipment, contrasted vividly present-day conditions with those that prevailed in the "get-out and get-under" days. He believed, however, that much still remains to be accomplished in the way of design for accessibility and interchangeability and that greater consideration should be given to the matter of tool requirements for maintenance.

He said

> It would seem that gears could be made with tightening holes in a standard size and position so that a single tool could remove a crankshaft gear from any car so equipped. Again, on a great many cars still on the market, it is necessary, in order to remove the transmission, to drag the rear axle from under the car, or to remove the radiator, loosen the engine and move it forward, and perhaps loosen the steering column to allow room for the engine to slide ahead.

Opportunities for improvement in these and in other respects were cited, and it was stated by way of contrast that the service department of one make of car is able to state that every nut and bolt on that car may be serviced with a wrench set consisting of but four sockets.

Further standardization in the adoption of parts such as bushings and roller bearings was advocated, and it was stated that the standardization of bolts, nuts and many other parts, accomplished by the Society, has greatly simplified the tool requirements of the maintenance shops.

Service and Sales

An intelligent buyer of a car first asks himself "Can I obtain satisfactory service when required?" The service factor, in other words, predominates in the sales consideration. The answer to this question regarding adequate service involves many items of peculiar interest to the maintenance man, including training of mechanics in the protection of the car-owner's property and in the efficient application of approved methods. The handling of a great number of cars in the shop was said to bring about the attitude that the work is merely perfunctory, resulting in slipshod methods. The importance of small details in this connection was emphasized and examples of uptodate methods were cited.

Dealers who claim to be unable to make their service department profitable should take a lesson from the many independent repair shops that are thriving without the prestige of a car agency.

Shops should be run to make a profit and should so operate on the flat-rate system as to remove the mystery from the car-owner's mind.

The Discussion

F. A. Bonham, of Durant Motors, Inc., in discussing Mr. Lord's paper, stated that an examination of the returned parts room will show that fully 40 per cent of the returned material has been damaged through neglect. A saving to the American public of approximately $400,000,000.00 a year could be effected by the adoption of some simple plan to eliminate this unnecessary loss. Mr. Bonham stated that his company has established a maintenance plan, based upon service units of 500 miles each, a nominal charge being made for each unit. Certain operations are performed each 500 miles, whereas others are required only at 1000 or 1500-mile intervals.

Lester A. Garrard, of the Standard Oil Co. of New York, reported that his company had increased sales and good will in the Orient by offering service that resulted in improved operation and better fuel-utilization. The adoption of this system necessitated the making of a careful study of service problems peculiar to the field.

In reply to a question from A. W. Einstein, of the Retail Delivery Association, examples were given where the dealer, for a definite consideration, assumes the responsibility for repairs, other than those caused by accident, that may be required during a given period.

A. Benhoff, of the Willys-Overland Co.; J. Willard Lord, of the Harrolds Motor Car Co.; Nicholas Dreystadt, of the Cadillac Motor Car Co.; and R. A. Armstrong, of the Oakland Motor Car Co., also discussed this point.

A. C. Nafe, of Dodge Bros., Inc., explained the Dodge national fleet inspection service, in which the fleet owner is supplied with blanks that he presents to the dealer, and that

entitle him to inspection of a particular vehicle as it travels extensively through various states. A charge of $1.50 is made for this service of inspection, and the dealer informs the headquarters organization of the results of the inspection, by returning to the factory a copy of the triplicate form.

Chairman Cumner reported an instance where, for a charge of $2.50, cars are completely greased.

In commenting on Mr. Hinckley's paper, W. R. Griswold, of the Packard Motor Car Co., intimated that it is difficult to reconcile the question of designing with consideration for repair men's tool equipment with designing for production.

Mr. Hinckley considered that a compromise must naturally be effected which will include due consideration of the various factors involved.

Otto M. Burkhardt, research manager of the Society, expressed the satisfaction with which the Society has cooperated with the National Automobile Chamber of Commerce and other organizations in promoting the acquisition of fundamental knowledge applying to engineering problems.

B. B. Bachman, of the Autocar Co., outlined the processes through which the engineering, production and sales departments have become articulate in accordance with the public demands. He felt that, in view of the close contact that is maintained between the public and the service department, this department should also become articulate and would thus be able to transmit more effectively to the engineering department the demands of automobile users.

Others who participated in the discussion were S. R. Castor, of the H. H. Franklin Mfg. Co., and F. C. Smith, of the Young Men's Christian Association.

Water Causes Corrosion

Mentioning the commonly accepted theory that corrosion in internal-combustion engines is caused by the action of sulphuric acid that is formed by the combination of sulphur with water that enters or is generated in the engine, Frank Jardine, of the Aluminum Co. of America, in his paper entitled Corrosion in Gasoline Engines Due to Water, spoke at the first session under the auspices of the Society of the sources of this water, the effects of its presence and the means for eliminating or neutralizing these sources and effects.

Blow-by and condensation of water on the crankcase walls were mentioned as two sources of water that would be difficult to eliminate entirely in the present design of engines. During cold starting the water was said to enter the crankcase in large quantities, approximately 80 cc. per hr. at 0 deg. fahr. collecting from various sources. The presence of this water and excessive quantities of raw gasoline accounts for the destruction of the oil-film that remained on the cylinder-walls when the engine last stopped. Thus the water comes in contact with bare walls and, unless the lubricating system delivers fresh oil to these parts immediately, severe wear, or scored pistons and cylinders, will result.

Instances were cited in which cylinder-walls were completely covered with rust in a period of less than ½ hr., and in one case, where water instead of oil was used in the crankcase, the pistons were rusted in the cylinders, within 10 min. after stopping the engine, so tightly that they had to be driven out.

Positive Oil Supply Necessary

Quick and positive supply of fresh oil to the bearing surfaces was said to be a uniformly successful method of combating the above difficulties. Great improvement was said to result, however, from the use of short water-jackets, steam-cooling and thermostatic control. The old-fashioned splash system of lubrication to pistons and cylinders was mentioned as the simplest, surest and cheapest method of quick and positive oil supply that has been developed today.

Mr. Jardine discussed in some detail various types of lubrication systems and reported the results of experiments with various oils operating under different bearing clearances. He made recommendations applying to the design of pressure lubrication-systems for successful operation at low temperature. In concluding his remarks, Mr. Jardine discussed favorably the value of castor oil for use in engines in storage.

W. R. Griswold

O. M. Burkhardt

Thorne on Corrosion

According to M. A. Thorne, of the Tidewater Oil Co., who presented a paper at the Corrosion Session entitled Notes on Crankcase Corrosion, agreement is nearly unanimous that water in the crankcase is responsible for engine corrosion. Continuing, he stated that water in the products of combustion is dependent upon the hydrogen content of the fuel, the mixture-ratio and the humidity of entering air.

The quantity of water that may be condensed on the cylinder-walls or in the crankcase depends upon the effectiveness of the pistons and the piston-rings in preventing leakage, the temperature of the cylinder-walls and crankcase and the extent of breather action. Condensation of water in the products of combustion will start at approximately 130 deg. fahr. when gasoline is the fuel, and at 123 deg. fahr. when a 50-per cent mixture of gasoline and benzol is used. The relative freedom of some engines from water accumulation is due to higher operating temperatures or better interchange of air through breather action with dilution and consequent reduction in the saturation temperature of the gases that are in the crankcase.

Sulphur and Water Found

While water alone will cause corrosion, the action may be accelerated by the formation of weak sulphurous or sulphuric acid. A reduction of the sulphur-content of fuels is desirable, but, even with more insistent demand, it would require some time to bring this about. The chemical activity from this and other contaminants would be negligible with effective control of water. Other troubles for which water is responsible would also be eliminated.

Frank Jardine

J. B. Fisher

Possible Corrosion Remedies

Much can be accomplished by developing pistons that will reduce "blow-by" and retain their effectiveness in use. In addition, means must be provided to (*a*) reduce the warming-up period and maintain the crankcase temperature sufficiently high to eliminate water from the oil and prevent condensation, and (*b*) ventilate the crankcase. The water formed during starting will thus be minimized and rejected, and only a small volume of vapor will be present in the engine when it is stopped.

The adoption of either steam or air cooling, with provision for controlled heating of the crankcase, offers favorable features in the solution of this problem. Passing preheated air through the crankcase has marked advantages. In existing equipment, radiator shutters and thermostatic control of jacket-water temperature, continuous oil-heating devices, oil filters and venting will all contribute in averting trouble. Methods that can be used in preventing condensation of water in engines will also reduce dilution and effect a more efficient utilization of fuel and oil.

Discussion at Corrosion Session

Many interesting side lights were thrown upon the topic of corrosion by a score or more of service engineers who

G. A. Round

A. L. Clayden

commented upon the papers by Messrs. Jardine and Thorne and added notes from personal experience.

J. B. Fisher, of the Waukesha Motor Co., cited an example of corrosion in the ball joints used in the connection between the governor and the butterfly valve and stated that it had been necessary to nickel-plate these parts.

A number of members discussed in detail the corrosion difficulties that prevail in the vicinity of Birmingham, Ala., these difficulties being attributed to the high sulphur-content of the benzol blends that contain benzol originating at the local steel plants.

President Horning and Otto M. Burkhardt, research manager of the Society, briefly reported in this connection that the Society's research on crankcase-oil contamination has clearly shown that the engines in this vicinity show the effect of the sulphur present in the blended fuels.

L. H. Pomeroy, of the Aluminum Co. of America, reported that experiments have shown that the amount of condensation is practically constant per revolution. In discussing aluminum cylinder construction he stated that owing to the ability of aluminum to become warmed quickly the troubles from condensation are markedly reduced.

R. E. Cole, of Dodge Bros., thought that the zinc coating on oil pans might be an important factor in minimizing the effect of acid in the engine.

G. A. Round, of the Vacuum Oil Co., in a written discussion that was read in his absence, reported that his research work had confirmed Mr. Jardine's findings and stated that oil flow through screens of varying mesh varies directly with the fourth power of their unit clear opening areas.

A. Ludlow Clayden, of the Sun Oil Co., in a short discussion that was read in his absence, differed with Mr. Jardine in his statements regarding the use of castor oil as a protective film. He remarked that although castor oil is undoubtedly a better rust deterrent than most mineral oils, this is due to characteristics of castor oil that also encourage it to produce gum. Castor oil was said also to augment the deposition of carbon, especially the kind that produces sticking valves. Mr. Clayden indicated on the other hand that the use of castor oil for slushing is entirely desirable.

Paul Brehm, of the Fageol Motors Co., described an oil-filter used on motorcoach engines that renders possible the continuous use of oil for runs aggregating 2000 or 3000 miles. The device utilizes felt as the filtering medium.

L. A. Garrard, of the Standard Oil Co. of New York, stated that in the Philippine Islands, where the average yearly temperature is about 80 deg. fahr., the scuffing of pistons and the corrosion of other parts is practically unknown.

Among those who contributed additional discussion of interest were S. R. Castor, of the H. H. Franklin Mfg. Co.; W. E. Williams; William Doyle, of the Fageol Motors Co.; R. A. St. Laurent, of the Standard Oil Co.; W. W. Sanford, of the Skinner Automotive Device Co.; Nicholas Dreystadt, of the Cadillac Motor Car Co.; John A. Schell, of the Morse Chain Co.; and Robert S. White, of the Valvoline Oil Co.

Trouble Diagnosis Session

Prefacing his address, Diagnosis of Engine Troubles and Chassis Noises, with a few general remarks relative to requirements in the service shop, John C. Talcott, of the Pierce-Arrow Motor Car Co., who spoke at the second session sponsored by the Society, stated that one of the most important requirements is the employment of men who can think. In studying car troubles the service man should first put the car through its paces to determine in what particulars its operation is unsatisfactory. He should make certain that there is a good spark and that all spark-plugs and the breaker points of the distributor or magneto are in satisfactory condition. He should also assure himself that gasoline can flow freely to the carbureter. Gaskets and intake-manifolds should also be inspected for leaks. Upon the completion of this preliminary examination the carbureter should be readjusted and an additional run made.

In case the trouble continues, the vacuum tank and connections should be carefully inspected, and the timing of the camshaft should be checked, especially if a chain is used; distributor or magneto timing should be checked; compression of cylinders should be found uniform and other obvious possibilities for trouble should be looked into.

Indications of Trouble

Improper seating of the valves becomes most noticeable at low speeds and often accounts for very uneven operation of the engine. Compression blow-by caused by rings that do not seat properly can usually be detected by a hissing sound that can always be heard more distinctly if the valve covers are removed or if the observations are made through the oil filler. Other causes of trouble include weak valve-springs that will not allow the valves to seat properly at high engine-speeds. Car speed is ofttimes reduced by dragging brakes or by tight wheel bearings.

Locating Engine Noises

A tight engine chain will usually manifest itself in the loud, even hum that increases in intensity with the speed of the engine. Tight gears are also revealed in this way.

A dull, heavy thump indicates excessive play in the main bearings and becomes more intense under heavy loads. Loose big-end connecting-rod bearings produce noises similar to those that result from too much play in the main bearings.

Looseness between the small-end connecting-rod bearing and the piston-pin produces a noise under steady running-conditions at about 25 or 30 m.p.h. Sometimes the same noise is produced in the small-end bearing when the pressure oil pipe leading to the bearing has become clogged.

Piston slap increases in volume as the load is increased and is more noticeable at low engine speeds than at high It is also more noticeable when the engine is cold, aluminum pistons being very susceptible to this trouble when cold. A loud, snapping noise, usually loudest at a car speed of approximately 30 m.p.h., often results from a tight piston-ring.

Certain valves run well with a clearance of 0.002 or 0.003 in., whereas in other engines the clearance may be as great as 0.020 and 0.025 in. This adjustment is a function of the cam design.

A clicking noise may often be traced to the oil-pump drive.

Worn bearings, or too much end play, often cause fan noises.

Generator noises usually originate either in the brushes or in the bearings. A brush that does not seat properly has a tendency to lower the battery-charging rate.

Clutch noises come from the driving teeth on the multiple-disk clutch or the driving pins on the single-plate clutch. The clutch throw-out bearing may produce a grating noise caused by lack of lubrication.

Location of transmission noises is often difficult because of the fact that these noises may be confounded with those originating in the universal-joints and rear axle. Loose high-speed gears in the transmission produce "hill rattle." Tight constant-mesh gears produce a hum that increases in intensity with the speed of the car. A bad burr or out-of-round constant-mesh gears may be responsible for disagreeable roughness in the transmission operation. Loose or worn bearings also produce roughness, and excessive end-play causes a pound during acceleration or deceleration.

Looseness in universal-joints can be detected by a marked take-up on acceleration or deceleration, or may cause a loud rattle under the car when travelling on rough roads with the clutch disengaged.

The most common of rear-axle noises is the gear whining. This can often be remedied by adjusting the backlash between the bevel-gear and its pinion. Tires may be responsible for serious axle noises that may be remedied by the adoption of properly designed treads.

Loose flanges on the pinion shaft will produce a single loud metallic snap when starting from rest or in reversing.

Other sources of rattles and other noises are the springs, bolts, clevises and brake rods and loose bands or shoes in brakes.

Mr. Talcott concluded his paper with the statement that the successful service shop must be able to investigate troubles expeditiously and to apply effective remedies with the least possible delay.

Talcott's Paper Discussed

Otto M. Burkhardt, manager of the Society's Research Department, emphasized a point brought out in Mr. Talcott's paper that service men should be capable of clear thinking and logical reasoning. He cited an instance to show that snap judgment may often predominate with sad results ensuing. He stated that troubles from vibration are often eliminated by the use of flexible members between the engine and the transmission. Mr. Burkhardt concluded his comprehensive discussion with well-chosen remarks concerning brakes.

F. J. Wells, of the Pierce-Arrow Motor Car Co., said that thoroughly trained men are an important requirement for service-stations. He believed that the diagnosing of troubles, whether they had to do with brakes or other parts of the car, was a task worthy of men of the highest type. An experimental engineer, he said, can do considerable to assist the service department and most useful results can only be obtained through the harmonious cooperation of all departments and a similar attitude of the car-owner.

J. Willard Lord, of the Harrolds Motor Car Co., stated that axle noises are often caused by very small amounts of dirt in ball or roller bearings.

B. B. Bachman, of the Autocar Co., stated that experience in service work, as in other pursuits, is the best teacher. He felt that much time and money are wasted because service men often undertake a task with a preconceived notion as to the trouble; this leads them astray and they fail to remedy expeditiously the difficulty in which they are interested.

J. C. Talcott

T. A. Boyd

Chairman Pomeroy illustrated this point by the remark of a college professor who stated that in experimental work one must be careful lest he find that which he is seeking. He made several observations regarding aluminum pistons and stated his belief that 90 per cent of the wear occurs because of poor lubrication in the first 2 or 3 min. of running. Aluminum pistons, he stated, can be increased in size by applying heat and then pouring hot water on the inside of the piston, an increase in diameter of from 0.0001 to 0.0010 in. being obtainable in this manner. This treatment may extend the useful life of the pistons from 10,000 to 15,000 miles.

Among others who discussed Mr. Talcott's paper was W. E. Williams, consulting engineer.

Squires Reflects Manufacturer's Attitude

At the Trouble Diagnosis Session, John Squires, of the Maxwell-Chrysler Motor Corporation, presented a most interesting paper entitled The Manufacturer's Reflection of the Service Field that was prepared by him in collaboration with Carl Breer, of the same company. This paper, which is printed in full elsewhere in this issue, merits very careful reading; it treats the service problem from a broad standpoint and includes a discussion of service opportunities, psychology in service, better cars and poorer service, needs for instruction, needs for service salesmen, reasons for loss in power, no cure-all for piston-ring troubles, taking the owner's statement, brake readjustment not needed, location and causes of trouble, causes and cure for noise, bothersome engine noises, pirate parts, where detonation occurs, clutch troubles, and benefits from special accessories.

Among those who contributed interesting discussion to the paper presented by Mr. Squires were Carl Breer, of the Max-

John Squires

Carl Breer

well-Chrysler Motor Corporation; J. Willard Lord, of the Harrolds Motor Car Co.; and R. A. Armstrong, of the Oakland Motor Car Co.

Alberty on Engine Troubles

Frederick Alberty, of the Gresham Automobile Co., presented a short paper at the Tuesday morning session entitled Automobile Engine Troubles—Their Causes and Remedy. His paper dealt chiefly with the premise that the mixture is not exploded in the cylinders in the form in which it leaves the carbureter and that none of the cars of today provide against this contingency. Mr. Alberty said in part:

> In the intake chamber, the valve-stem works up and down in a guide and to permit these metal parts to work, one within the other rapidly and freely without sticking as necessity demands, clearance must be provided around the valve-stems. Where clearance is provided leakage occurs as space enough is left for air to find its way into the intake chamber . . . then when the charge of gas is introduced it is mingled with this air and a new mixture is formed. . . . All the intake chambers do not take in the same amount of air due to location and the wear of parts so a number of differently proportioned mixtures are formed in the different cylinders. . . . The result is that the engine cannot use all its cylinders to produce the power intended and what power is produced is uneven with all the attendant evils. . . . Valve packing installed inside the intake chamber will effectively seal the clearance against leakage.

Mr. Alberty described a simple means for packing to bring about the results above indicated and reported several tests in which improved operation was shown to result from applying this expedient.

Automobile Testing for the Public

F. E. Edwards, of the Automobile Testing Laboratory, Inc., described a laboratory that is available to the public where experts test a vehicle to enable the owner to advise the repair man what he desires done to his car. Another phase of the work is for the benefit of the buyer of a used car, who desires to know either what he has bought or what he will buy. This necessitates a systematic and progressive method of diagnosing car troubles. Each unit is tested and by a process of elimination the difficulties are located. The equipment included in the testing laboratory is similar to that employed by automobile builders and was said to have been used most effectively in the interests of the motoring public.

Automotive Fuels and Service

"The automobile is a chemical factory on wheels," said T. A. Boyd, of the General Motors Corporation, in a paper entitled Fuel from the Service Standpoint, that was presented at the final session of the Service Engineering Meeting. Mr. Boyd elaborated this remark by tracing the utilization of fuel through various stages as its energy is converted into useful work by the internal-combustion engine. The speaker included in his paper an extremely interesting discussion of several topics including the nature of gasoline, sources of motor fuel, service problems arising from the fuel, gum in gasoline, putting blended fuels into old cars, the relation of fuel to engine corrosion, improper fuel characteristics, the service man and fuel economy, and fuel hazards in service-stations.

It is strongly recommended that the persons interested in this topic take the time to study Mr. Boyd's valuable contribution when it is published in an early issue of The Journal.

The discussion of Mr. Boyd's paper dealt chiefly with the characteristics of benzol fuels. H. R. Cobleigh, of the National Automobile Chamber of Commerce, and J. Willard Lord, of the Harrolds Motor Car Co., were among those who were especially interested in this phase of the fuel subject. Mr. Boyd stated that, when properly refined, benzol makes a fine motor fuel provided it is blended with a suitable distillate. Benzol was said to have a very high percentage of carbon as compared with gasoline and often an excessive amount of sulphur. In reply to a question from Mr. Cobleigh, Mr. Boyd stated that the average service-station or operator could not easily test his fuel to determine whether or not the sulphur-content might be excessive. Mr. Boyd further stated, in reply to a question from Mr. Lord, that it is possible to cut down the mixture while using benzol since the latter is much heavier than gasoline.

With reference to the recently marketed fuels with anti-knock characteristics, Mr. Boyd stated that two general types exist, one of these being produced by vapor phase cracking and the second being a fuel refined from California crude and possessing anti-knock characteristics.

Blanchard Discusses New Devices

New Devices for Improving Car Operation was the subject of a very interesting paper presented at the final session of the Service Engineering Meeting by Donald Blanchard, of *Motor World Wholesale*. Mr. Blanchard stated in part:

> Current progress in automotive design is not the result of radical changes but is due rather to detail improvement. It has been evident for some years to all who have followed the trend of design that development at the present time is by evolution as contrasted with revolution. Apparently the engineers of the industry consider that, on the whole, existing designs are fundamentally correct and consequently their attention has been directed chiefly toward the refinement of the product.
>
> In this process of refinement, the developments of the last year show that more attention is being paid to lubrication than to any other phase of design. The need for improvement along this line has been generally recognized for, as one prominent engineer said earlier in the year: "The lubrication conditions existing in the average automobile would not be tolerated in any other machine."
>
> To some extent the motorist has been at fault as he is prone to neglect his car. But it is likely to prove a difficult job to change his habits, so the engineer must take them into consideration and design his car so that such neglect will do the minimum of damage. It would be a fine thing, for example, if the motorist could be induced to idle his engine for 10 or 15 min. before starting out on a cold morning, but he won't.
>
> However, the motorist is not entirely to blame for the troubles that have been caused by faulty lubrication. In some cases, he has had little control over the matter, as the cause has been inherent in the design. The elimination of such inherent faults has provided, and is providing, some of the most knotty problems that the automotive engineering fraternity has been called upon to solve.
>
> Progress in lubrication during the last year has been toward the following objectives: (*a*) improving the quality of the lubricant delivered to the bearing surfaces; (*b*) provision of an adequate supply of lubricant under all conditions; (*c*) reduction of the frequency with which the bearings must be lubricated, and (*d*) elimination of the need for periodic lubrication.
>
> Failure to provide the engine bearing-surfaces with oil of proper quality has been a prolific cause of trouble. Dilution of the lubricant with unburned fuel has caused wear at an accelerated rate and the presence of water and solid foreign matter also has had serious effects.

Mr. Blanchard continued his treatment of fuel and oil utilization by explaining the construction and operation of oil rectifiers, aerators, oil filters, and crankcase ventilating systems. He touched briefly upon the use of air-cleaners and described the more common types of central chassis-lubricating systems.

Devices for damping torsional vibrations in the crankshaft

NATIONAL MEETINGS CALENDAR

ANNUAL DINNER
New York City—Jan. 14, 1926

ANNUAL MEETING
Detroit—Jan. 26-29, 1926

THE CARNIVAL
Detroit—Jan. 27, 1926

were said to have attracted considerable interest recently and the subject of road illumination was mentioned as being of primary importance.

In the discussion of Mr. Blanchard's paper, the consideration of steam cooling occupied a position of prominence. Among those who contributed to the discussion were W. W. Sanford, of the Skinner Automotive Device Co.; J. Willard Lord, of the Harrolds Motor Car Co.; Walter S. Nathan, of the Ajax Motor Co.; A. W. Pope, Jr., of the Waukesha Motor Co.; L. W. Oldfield, of the Northern Motors Co.; H. R. Cobleigh, of the National Automobile Chamber of Commerce; John Squires, of the Maxwell-Chrysler Motor Corporation; Arthur E. Nafe, of Dodge Bros., Inc.; F. A. Bonham, of Durant Motors, Inc.; W. E. Williams, consulting engineer; F. C. Smith, of the Young Men's Christian Association; R. H. Craig, of the E. V. Stratton Motor Co., and C. L. Knopf, of the Sinclair Refining Co.

Members Visit Exposition

At the invitation of Commissioner W. M. Webster and the directors of the Automotive Equipment Association, many of those who attended the Service Engineering Meeting took occasion to visit the annual convention and exposition of the Association. Nov. 11 had been set aside by the Association as the Society of Automotive Engineers and Servicemen's Day, and considerable benefit was derived by those fortunate enough to take advantage of the opportunity to participate in the activities of the Association.

Acknowledgment

The program for the Service Engineering Meeting was arranged under the able guidance of Otto M. Burkhardt, manager of the Society's Research Department, for the Society, and under the capable direction of the Service Committee, of which Alvan Macauley is chairman, for the National Automobile Chamber of Commerce.

The Chicago Section of the Society was active in promoting the meeting and several of its members, including W. L. Kaiser, chairman, H. F. Bryan, G. W. Gaidzik, L. W. Oldfield, H. L. Sharlock and P. S. Tice, functioned as a local committee whose efforts were directed toward the success of this event. Walton Schmidt, of the National Automobile Chamber of Commerce, also assisted with the arrangements.

TRANSPORTATION TOPICS HOLD INTEREST

Record-Breaking Philadelphia Meeting Attracts a Large Number of Leaders

After examining the 325 registration cards at the Transportation Meeting, that was held at the Benjamin Franklin Hotel, Philadelphia, Nov. 13 and 14, a prominent engineer who has attended practically all National Meetings of the Society during the past decade remarked in substance that this meeting has attracted the accepted leaders in the field of automotive transportation, and the increase in attendance over that recorded a year ago indicates clearly that the Society is answering a real demand by arranging an event of this nature. Many new and interesting phases of the automotive transportation problem were considered extensively by the speakers and discussers at three technical sessions that were devoted respectively to Standardization, Freight Handling, and Motorcoach Operation. It was interesting to note that numerous persons identified with the railroads and other branches of transportation were attracted to the meeting.

In the Transportation Banquet on the evening of Nov. 13, the members and guests found a pleasant opportunity for relaxation and enjoyable social intercourse. The principal addresses by Samuel M. Vauclain, president of the Baldwin Locomotive Works, and Dr. E. J. Cattell, of the Philadelphia Chamber of Commerce, were welcomed enthusiastically and all who heard them considered the evening well spent.

The final event of the Transportation Meeting took the form of an inspection visit to the maintenance plant of the Philadelphia Rural Transit Co., operator of a large fleet of gasoline-electric motorcoaches. This trip was arranged through the courtesy of R. H. Horton, president of the Rural Transit Company, who supplied motorcoaches to carry the members to and from the plant, and guides to explain the many interesting points that were seen.

Too great credit cannot be assigned to the Automotive Transportation Meeting Committee and to the members of

A. W. Herrington — C. O. Guernsey — G. Walker Gilmer — A. K. Brumbaugh

Some of Those Who Contributed to the Success of the Automotive Transportation Meeting

the Pennsylvania Section who worked diligently to assure the meeting of pronounced success.

A news account, covering the high spots of the meeting, will be found on the following pages; several of the papers appear in this issue of THE JOURNAL and others will follow in due course.

STANDARDIZATION AND OPERATION

Viewpoints of Builders, Railroads and State Presented in Three Papers

Standardization and its effect upon the economical operation of automotive vehicles as viewed from the standpoints of the builder, the railroads and the State, were discussed at the opening session of the Automotive Transportation Meeting held at the Benjamin Franklin Hotel, Philadelphia, on the morning of Nov. 13.

The Manufacturer's Attitude Toward Standardization was presented by E. W. Templin, of the Six-Wheel Co.; the Motorcoach and the Railroad—Influences of Standardization Upon Operation was interestingly outlined by H. F. Fritch, of the Boston & Maine Transportation Co.; and Pressing Motor Vehicle Problems from the Viewpoint of a State were elucidated by R. B. Stoeckel, commissioner of motor vehicles, State of Connecticut. The lively discussion that followed showed the keen interest of those present in these topics. Past-President B. B. Bachman presided.

B. B. BACHMAN

E. W. TEMPLIN

After first outlining the fundamental requirements of a motorcoach that is intended to serve as a transportation unit and stressing the relative importance of the various factors that enter into safety, comfort, economy and performance, Mr. Templin showed the effect upon these factors of acceding to the requests of operators for certain additions or changes to be made in the motorcoach before they will fully agree to sign the contract for its purchase.

CHANGES CAUSE LOSS OF EFFICIENCY AND INCREASE COST

Many of these details, he declared, not only produce no gain, but frequently a considerable loss in operating efficiency, and add greatly to the initial cost of the vehicle. Making changes in the chassis frame to overcome or avoid projections in the floor sometimes involves an additional expense of from $1,000 to $2,000 in producing a sample motorcoach besides delaying delivery, the extra expense being necessitated by temporary special tools and forms and handwork. In one order for 50 motorcoaches an additional cost of $4,900 for special tools increased the cost to the builder $98 per vehicle. When the cost of engineering and experimental work was added to this sum, the increased cost of the special frame amounted to $178 per motorcoach.

To carry out further the desires of the operator with regard to minimizing the interference to passengers, special axles were required, also special frame brackets, brake rigging and gas-tank supports. These increased the estimated cost by $45, bringing the total extra cost of obtaining the special feature to $254 per motorcoach.

Mr. Templin described in detail the fundamental requirements for successful operation or riding-comfort in a well-designed motorcoach, such as the steering and braking features, the gear shift, clutch angle, entrance and exit conditions, smooth riding, comfortable seats, wide aisles, headroom, ventilation, freedom from objectionable noises, carrying capacity, neat appearance, ease of maintenance, long life before overhauling, economy of fuel and oil, acceleration and average speed.

STEERING AND BRAKING

In general, as regards these matters, Mr. Templin believes that the steering should be reasonably easy and of sufficient range to allow proper handling in traffic and the turning of corners with the least effort. The braking must be of sufficient capacity to hold the motorcoach safely under load in the kind of service for which the vehicle is intended to operate; the brakes should be consistent, of reasonably long life, should not heat the wheels and tires excessively and should be easy to operate. Such variations in the requirements as are involved in requests for special brake-linings necessitate expensive testing and, in the end, if not entirely satisfactory, are liable to be blamed on the builder of the motorcoach.

Requests for modification of most of the other details mentioned above are few, with the exception of carrying capacity and acceleration. After a chassis has been developed for a given capacity, the seating arrangement can usually not be changed without (*a*) discomfort to the driver, (*b*) discomfort to passengers, (*c*) excessive overhang of the chassis or (*d*) overloading. This is in addition to the cost and inconvenience of the redesigning and rearranging. Specifications regarding electric transmissions for both single and double-deck motorcoaches provide the maximum smoothness of "pick-up" but whether the demand for so high a quality of smoothness will be general remains to be demonstrated.

Mr. Templin closed with a plea to motorcoach operators for forbearance in the matter of changes of design or in requests for special features until they can be given seasoned consideration and tryout, so that they may in time become general and standardized improvements.

EFFECT OF MOTOR-VEHICLE COMPETITION ON RAILROAD REVENUES

The effect of passenger-car and motorcoach competition on railroad revenues and the results obtained by the Boston & Maine Railroad in adopting the motorcoach for use in certain districts to supplement or supersede steam railroad service were described by Mr. Fritch. To the private automobile, he said, could be attributed largely the decrease in the total number of passengers carried by the railroads of the Country between 1920 and 1924; in the former year the total number was 1,269,913,000; in the latter, 913,348,000, a decrease of 27 per cent.

The effect was said to be most noticeable in the passenger earnings in the pleasure-riding class and in sparsely settled territory where train service at the best has been infrequent; and, with depleted revenue, it has become still less frequent.

The future of the railroad, in Mr. Fritch's opinion, lies in operating main-line rail-service with properly organized motor-vehicle service as an auxiliary, to act as a feeder from territory in which rail service can no longer be justified. Feeling that it should make proper use of the motorcoach, the Boston & Maine Railroad has organized an auxiliary corporation to carry on certain motor-vehicle activities, such as store-door delivery and road haul. It is the road's intention, Mr. Fritch said, to replace train service with the motorcoach where the vehicle can perform the service more economically, supplement rail service between trains, act as a feeder to the rail lines from new territory and to main lines

Photograph by Bachrach
HOWARD F. FRITCH

ROBBINS B. STOECKEL

serving local stops, and as a touring service for passengers who travel for pleasure and desire to go over the highways.

MOTORCOACH OPERATION BY BOSTON & MAINE RAILROAD

Four types of operation in which motorcoaches have been used by the Boston & Maine Railroad to amplify rail service have met with satisfactory results, and the characteristic features of the vehicles that have fulfilled the requirements were described.

Summarizing, Mr. Fritch said that the railroads, to strengthen themselves and increase their ability to provide good main-line service at the lowest possible cost, must make use of the motor vehicle to supplant and replace rail service where the motorcoach can perform the service more economically. Such a policy is to the advantage of both the community served and the railroad. The railroads, as well as other motorcoach operators, should work conscientiously with the motorcoach builders to promote standardization of construction. Any improvement of the motorcoach along the line of maintenance and operation will assist the railroads in serving communities that it is becoming increasingly difficult to serve by rail because of their light traffic. He predicted that the railroads would make large use of the motorcoach. Mr. Fritch's paper is printed in full on p. 583 of this issue of THE JOURNAL.

VIEWPOINT OF THE STATE

As the purpose for which the motor vehicle exists is to move persons and things from place to place with expedition and safety, said Mr. Stoeckel, in discussing the problems of motor-vehicle administration by states, the immense increase in numbers of these vehicles and the consequent multiplication of the problems of movement and safety, coupled with the fact that the control of such vehicles seems to be a subject for state regulation, make it imperative that the laws and methods of one jurisdiction be compared with and adjusted to those of others. A motor-vehicle law, to be practical and effective, must meet the conditions that exist where it is to be administered. It is clear that standardization of law as to traffic cannot be based upon any one element, such as population, territorial extent or number of cars, but must be founded upon the whole existing condition of traffic.

Distinguishing between a uniform law and a model law, Mr. Stoeckel defined a uniform law as one that governs a condition in different jurisdictions by identical principles, language and penalties; a model law, as a form to work to, which within its scope expresses all possible principles in tested language and provides minimum and maximum penalties. From such a law a selection can be made to fit any condition.

Regulation of traffic must be adapted to conditions. When the conditions are simple, few and simple enforcement machines are required; when they are complicated, persons charged with their management need every possible tool.

Standardization of equipment is also essential to the extent that number plates, for instance, should always be placed in definite positions at both the front and the rear of the cars.

OVERLOADING

The problem of overloading is important. As regards passenger cars, the number of seated passengers usually determines the rated load and overloading may cause the brakes and safety equipment to become ineffective. Motor trucks are usually limited by what is considered to be reasonable road load, nominally about 26,000 lb. As that of about 90 per cent of the total traffic on the highway is less than 10,000 lb., the suggestion has been made that highways should be graded according to their types of construction and vehicles segregated according to weight, the heavy vehicles being confined to certain routes.

The discrepancy between the builder's guaranteed rating of a truck and his sales argument that the truck can carry more than its rated load has been met by the state administrator by the establishment of the minimum and the maximum rating on each truck. The evolution of this principle brought about the final result that any user of a commercial motor-vehicle may register it for the minimum or for any load under or including the maximum. This load appears on the registration certificate and is termed the "registered capacity."

Among other matters that will require careful attention are the determination of the desirability of intrastate motorcoaches and the control, routing and management of those in interstate service, the regulation of speed, maximum, minimum and average, and the size of vehicles, particularly their width. Mr. Stoeckel's paper is printed in full on p. 597 of this issue of THE JOURNAL.

LIMITATION OF PRESSURE AND SPEED

In the discussion that followed the presentation of the papers G. H. Scragg stated that, in his opinion, the loads to be carried by the road should not be governed by the weight of the vehicle alone. It was obvious, he said, that a load of 30,000 lb. carried on six wheels would do less damage than a load of 26,000 lb. carried on four; also, that a 26,000-lb. load traveling at 25 m.p.h. would do more damage than a 30,000-lb. load traveling at 10 m.p.h. This question, he believed, could be governed by basing restrictions on pressures and by putting a limit on the speed at which vehicles equipped with solid tires might travel.

Referring to hasty legislation regarding the control of motorcoach operation, Mr. Scragg remarked that if such laws continue to be made interstate control would not be needed because, with such a multiplicity of laws, it will be illegal for a vehicle of one state to operate in a state adjacent to its home. He cited numerous instances of conflicting enactments in adjacent states. It is conceivable, he said, that each of the 48 states could believe that it had a better

W. E. MARTIN

JOSEPH W. MULLAHEY

G. C. HECKER

R. E. PLIMPTON

method of governing its motorcoach operators than the other 47 and, as a result, manufacturers might be compelled to build 48 models of chassis and body to take care of the different states. He urged that the Society exercise great care in rushing recommendations for standards until it was sure that development would not be retarded.

TRAVEL BETWEEN BOSTON AND PORTLAND

Replying to questions by F. C. Horner, Mr. Fritch stated that only one motorcoach is at present operated by the Boston & Maine Railroad, and that it will be taken over by the Transportation Company, which is not owned by, but functions in the interest of the Railroad Company, as soon as the formality as to license has been taken care of. The Transportation Company operates 29 motorcoaches. Regarding the statement that 77 per cent of the total number of travelers between Boston and Portland would have gone by train if motorcoach service had not been available, Mr. Fritch said that he had stopped at 77 per cent because he was not interested in boats; that a large percentage of the remaining passengers had said that they would have gone by boat. Regarding control, Mr. Fritch believes that a satisfactory arrangement would be to have sufficient power delegated to the State Commissions, the Interstate Commerce Commission coming into the picture only in case of dispute between neighboring states. For handling baggage other than hand baggage a separate charge is made and a contract was made with a local truckman. Both four and six-cylinder engines had proved very successful and he was not prepared to recommend one to the exclusion of the other. Small-size tires are satisfactory in smaller city and suburban operations, but he was convinced that they were not adequate for the ordinary de luxe motorcoach.

Chairman Bachman's query as to the Boston & Maine Railroad's considering altering the roadbed to allow motorcoaches to operate over the Railroad's right-of-way was answered in the negative. Mr. Fritch believed that the existing highways were capable of absorbing considerably more traffic than they now have.

EDWARD J. FROST

F. A. WHITTEN

SAVING IN FIRST COST AND MAINTENANCE

G. C. Hecker expressed the advantages of standardization as a saving in first cost and economy of maintenance. He said that he had been reliably informed that, with a reasonable degree of standardization of design, a saving in first cost of from $1,000 to $1,500 could be obtained in an average motorcoach. In 1920, 16 electric-railway companies were operating 75 motorcoaches over a few miles of route; in 1924, 251 electric railways operated 4452 motorcoaches over 12,060 miles of route. Although many of the routes are unprofitable, business is increasing at a rate which indicates that some of them will undoubtedly become profitable.

At its last convention the American Electric Railway Association adopted a standard classification for motorcoach accounting that will be reprinted and distributed to all electric-railway companies. With standardization in accounting a comparison of operating results will be possible.

In replying to M. C. Horine's questions regarding various details of motorcoach construction and operation, Mr. Fritch added the information that he considered the proper place for baggage to be inside; that although he had no motorcoaches in which the hand baggage is put in through the back of the body, he favored that method. He was not in favor of the driver's being enclosed.

HANDLING FREIGHT BY MOTOR TRUCKS

Afternoon Session Discusses Congestion, Store-Door Delivery and Containers

Freight handling in its various aspects: as it is performed as an auxiliary to the service of the Pennsylvania Railroad; as it is maintained by the railroads of Great Britain; as it exists in the metropolitan area of New York City; and as it is accomplished by containers, occupied the attention of the afternoon session of the Automotive Transportation Meeting, at the Benjamin Franklin Hotel, on Friday, Nov. 13.

Freight Handling with Trucks, which are used successfully by the Pennsylvania Railroad for less-than-carload shipments, was described by Joseph L. Scott, of Scott Bros., Philadelphia; an Informal Talk on Store-Door Delivery was given by J. W. Roberts, general superintendent of transportation of the Pennsylvania Railroad System; Freight Handling Conditions in the metropolitan area of New York City were vividly depicted by Major Elihu Church, transportation engineer, Port of New York Authority; and Some Notes on Freight Containers were submitted by G. McCall, assistant terminal engineer, and C. Froesch, engineer, of the International Motor Co., New York City.

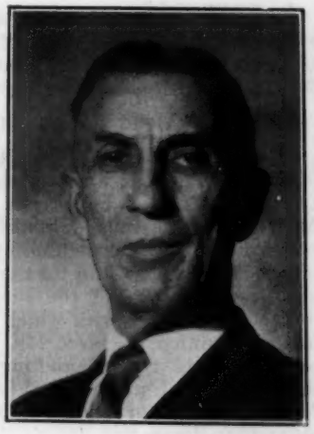
About 2 years ago, said Mr. Scott, the Pennsylvania Railroad having determined to make an experimental demonstration of the handling of less-than-carload freight by motor truck, selected a section of the main line, 32 miles long, between Overbrook and Downington, for this operation. This service having proved satisfactory after 3 months' trial, additional units were installed on the Maryland, Trenton, New York and Atlantic divisions. Motor trucks now give uninterrupted daily service to 469 towns in the States of Maryland, Pennsylvania, New Jersey and Delaware, covering 1348 railroad miles daily. The method of operation of this service and the costs and advantages obtained were given by Mr. Scott, whose paper is printed in full on p. 607 of this issue of THE JOURNAL.

SERVICE IN GREAT BRITAIN

Having devoted several weeks last summer to a study of the collection and delivery service maintained by the railroads of Great Britain, Mr. Roberts made application of his observations to conditions in this Country. The outstanding features of the British system that should be considered by American railroads he summarized as follows:

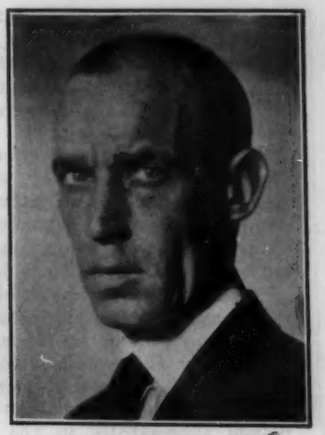
Recognition of the principle that collection or delivery

Charles Froesch



J. W. Roberts

Major Elihu Church



J. L. Scott

FOUR OF THE AUTHORS OF THE PAPERS THAT WERE PRESENTED AT THE FREIGHT-HANDLING SESSION

of freight by a railroad constitutes a service in addition to the rail-haul service that should yield to the railroad a return consistent with the expense incurred in rendering the service.

Recognition of the principle that traders shall have the right to decide whether they will or will not accept cartage service by the railroad.

Recognition of the principle that traders accepting cartage service must do so on a 100-per cent basis.

Adoption of the form of cartage service best adapted to the requirements of individual stations or localities.

Practically 25 per cent of the cartage service rendered by the railroads of Great Britain is performed by contractors who are in every way, insofar as operation and contact with the public are concerned, subject to the direction of the railroads.

The maintenance of a large number of receiving stations which serve as concentration points for parcels and freight collected by road vehicles, and from which the parcels and freight are subsequently transported by other similar conveyances to the railroad stations.

By schedules for the concentration of parcels and goods freight, the railroads are enabled to reduce the road-vehicle mileage and to avoid handling a large volume of freight that would otherwise have to be forwarded to transfer stations.

The average expense per ton, influenced largely by the cost of labor, is: horse-drawn vehicles, $1.37; electric trucks, $1.62; steam trucks, $0.85; and gasoline-operated trucks, $1.15.

Road vehicles, although assigned specifically to either collection or delivery, are used indiscriminately when necessary.

NIGHT OPERATION

Night operation, by effecting a clean-up of inbound and outbound traffic daily, results in curtailment of the day force and of expense, besides ensuring early morning delivery of freight to receivers.

The hauls are comparatively short, making practicable overnight movements from shipper to receiver.

A large percentage of the total traffic that classifies as general merchandise is composed of small lots, comprising both individual packages and individual consignments.

Necessity for single control of road vehicles to prevent congestion and kindred difficulties at many freight stations.

Establishment of concentration points for goods freight that will provide for consolidations and the advantages that accrue from them.

Of the total number of vehicles owned and used by the four railroad systems of Great Britain, 32,428, or 94 per cent, are horse-drawn.

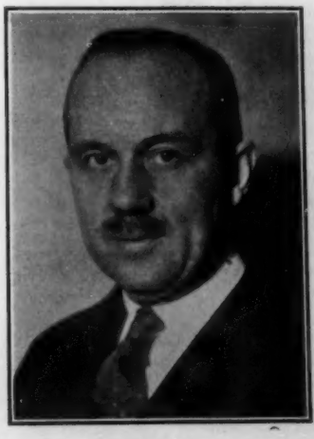
Custom has prevailed in Great Britain for a long period, and rights have become as definitely established under the vested right principle as they would be under a statutory law.

FEATURES APPLICABLE TO THIS COUNTRY

The principal conclusions drawn by Mr. Roberts as to the essential features of any collection and delivery service plan that would be applicable to this Country are as follows:

F. C. Horner

H. S. Baldwin



James Monroe

F. J. Scarr

THE CHAIRMAN OF THE FREIGHT-HANDLING SESSION AND THREE OF THE DISCUSSERS

Except to a limited extent in New York City and certain of the larger cities of the United States, the conditions in this Country that control or even affect in a large measure the operation of railroads in meeting the demands of commerce are radically different from those of Great Britain.

In that country, collection and delivery service on a broad scale is a necessity, whereas in this Country it is necessary to a limited extent as a progressive step, a means of effecting economies and expediting the movement of traffic by minimizing congestion on public highways and at freight stations through the concentration of traffic and the more effective regulation of road vehicles than is possible when such service is performed entirely by outside interests.

Although the system in vogue in Great Britain, which is the result of many years' experience, seems to be adapted to their needs, the same plans cannot be employed successfully in the United States, where the service should be limited at first to places where conditions require it and where it should be developed gradually.

Because of the variations in the demands for cartage service by shippers and receivers of freight in the United States, railroads should not undertake to equip themselves with road vehicles and other equipment for performing the service, but should employ agents.

Initial and subsequent steps in the development of cartage service should be predicated upon the results of a thorough analysis of the traffic that would be involved, to determine the kinds, volume, routings, possible consolidations, elimination of unnecessary movement, duplicate handling and the like that are essential to economy without altering the competitive situation as it applies to different roads.

Limitation of Service

Initial cartage service should be limited to the hauling of the freight, exclusive of perishable articles, that is handled over freight-station platforms.

Whenever conditions require it, delivery limits should be established and zoning of the delivery area determined.

Costs of service should be determined and an average rate applied on each of the railroads involved, within designated limits.

Shippers and receivers accepting cartage service should do so on a 100-per cent basis.

Contact with the public regarding the initial steps for providing cartage service should be through regional advisory boards.

Conditions in certain localities in this Country will undoubtedly make necessary the institution of collection and delivery service as a means of avoiding the expansion of freight-handling facilities at large cost, reducing the demands upon congested highways and expediting the dispatching and movement of traffic.

Traffic Congestion in Manhattan

In describing the congested traffic conditions in the vicinity of the various railroad terminals and piers of Manhattan and the remedies that have been proposed for relieving them, Major Church confined himself largely to the same topics covered in a paper presented by him before the October meeting of the Metropolitan Section, an extensive digest of which appeared on p. 430 of the November issue of The Journal.

The worst thing with which the railroads have to contend, in their opinion, declared Mr. Froesch, in discussing freight containers, is the rehandling of merchandise; containers serve the dual purpose of reducing idleness losses on all forms of transportation equipment and of eliminating the rehandling losses.

Among the other advantages of using containers, continued Mr. Froesch, are the saving due to cutting truck and railroad car-loading time to the minimum, the prevention of pilfering, the relieving of congestion at loading platforms, the providing of a direct means of establishing the store-door delivery system, and, in the case of suitable freight, the saving of the cost of crating.

W. F. Banks

H. C. Crowell

J. F. Winchester

E. L. Clark

Some of Those Who Attended the Freight-Handling Session

It is probable that, if the present plans of the Port of New York Authority are carried out, the container will be given an opportunity to show its worth. These plans call for the establishment of 10 off-track freight stations that will be located in the center of zones of approximately equal freight density, and that will be served by motor trucks carrying containers.

Requirements for Containers

The development of containers was followed from the time they were patented in 1875 by Leon Dathis, of Paris, France, to the present day. First among its requirements for successful use was mentioned light weight, for, with the weight limits imposed by State authorities on motor trucks, the greater the weight of the container, the less will be the weight allowance available for the pay-load. Next in importance is size, which must be such that perfect coordination will be possible among the four "ways" of transportation: doorway, highway, railway and waterway. It must be equipped with wheels so that it can be taken through a doorway for loading or unloading; its width must be governed by the maximum allowed on the highway; its height must comply with the regulation in force on steamships, and its length must be suitable for use on both motor trucks and railroad cars.

The railroads today maintain 35 pier stations around Manhattan Island. It has been estimated by J. J. Mantell,

vice-president of the Erie Railroad, that, by container distribution from properly located distributing-points on the New Jersey shore to distant lighterage points, more freight than is handled today could be handled with a maximum of 8 piers.

ECONOMIC STATUS OF MOTOR VEHICLE

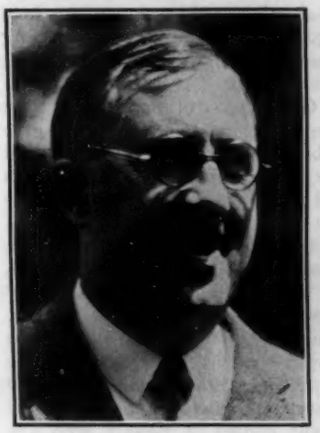
Large Audience at Banquet Hears Masterly Addresses by Vauclain and Cattell

More than 300 members and guests of the Society assembled in the ballroom of the Benjamin Franklin Hotel, Philadelphia, at 6:30 on the evening of Nov. 13, the occasion being the Automotive Transportation Banquet.

President Horning in his opening remarks sounded most felicitously the keynote of good fellowship, as he welcomed to the banquet all those in attendance and in his inimitable fashion introduced the toastmaster, A. F. Masury, vice-president and chief engineer of the International Motor Co.

Toastmaster Masury, after responding with ready wit to President Horning's introduction, had the happy idea of asking General Manager Alfred Reeves of the National Automobile Chamber of Commerce to introduce to the audience the noted persons at the speakers' table. As Mr. Reeves announced the names of these gentlemen, the audience applauded and each gentleman when introduced arose at his place. The following, in addition to President Horning, Toastmaster Masury and Mr. Reeves, were seated at the speakers' table: A. W. Herrington, consulting engineer and chairman of the Transportation Meeting Committee; Major Elihu Church, transportation engineer of the Port of New York Authority; Ernest T. Trigg, chairman of the executive committee of the Philadelphia Chamber of Commerce; Theodore D. Pratt, general manager of the Motor Truck Association of America; Brigadier-Gen. A. C. Dalton, Quartermaster Corps; Samuel M. Vauclain, president of the Baldwin Locomotive Works; Dr. E. J. Cattell, of the Philadelphia Chamber of Commerce; William A. Redding, trustee of the University of Pennsylvania and a patent attorney of New York City; R. H. Horton, president of the Philadelphia Rural Transit Co.; H. F. Fritch, president of Boston & Maine Transportation Co.; G. C. Hecker, special engineer of the American Electric Railway Association; C. O. Guernsey, chief engineer of J. G. Brill Co. and chairman of the Pennsylvania Section of the Society; and B. B. Bachman, of the Autocar Co., and a past-president of the Society.

A friendly message from the hostess city, Philadelphia, was brought to the guests by Mr. Trigg, who gave a cordial welcome on behalf of the Philadelphia Chamber of Commerce and extended a most hearty invitation to the Society to meet there in 1926 when Philadelphia will celebrate the 150th anniversary of the adoption of the Declaration of Independence in that city.



H. L. Horning

A. F. Masury

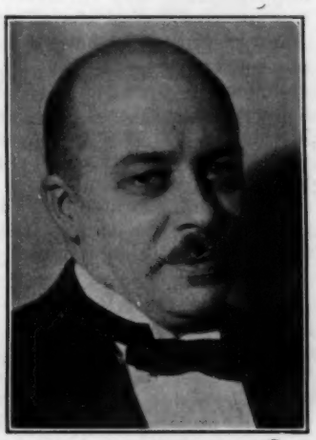
After graciously acknowledging Mr. Trigg's welcome and assuring him that Philadelphia's invitation would receive most thorough consideration, Toastmaster Masury introduced Dr. E. J. Cattell, who several times during the evening was referred to as a "parcel of sunshine" and whose address left no doubt in the minds of his audience as to the fitness of the designation. A brief summary of his remarks follows. It is planned to print Dr. Cattell's talk in an early issue of THE JOURNAL.

Optimistic Address by Cattell

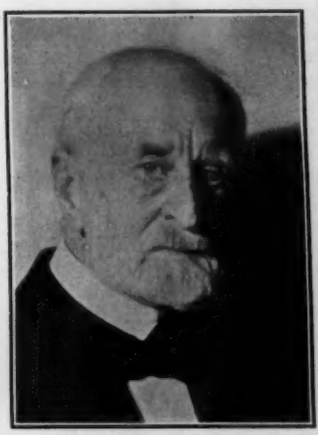
Seconding Mr. Trigg's invitation and expressing a desire that the Society hold its Summer Meeting there, Dr. Cattell referred to Philadelphia as the original sport center of America, its sports activities dating back to fox hunting in 1695. Humorous remarks about the growth, activity and virility of the City of Brotherly Love established a feeling of most cordial friendliness between the speaker and the audience, after which Dr. Cattell voiced in no uncertain terms his belief in America and her future. He stated that within his memory the wealth of this Nation has grown 10 times as fast as the number of people and pointed out that, unless the average home shows ten times the evidence of expenditure as when he was young, the level of living is relatively lower than was the case 65 years ago. Therefore, he said, all this talk about the dangerous extravagance of today comes chiefly from persons educated beyond their intelligence and muscle-bound between the ears. The fallacy of measuring American life by the standards of Europe was indicated, a contrast being made between the ways in which wealth is accumulated there and here.

In Europe, said Dr. Cattell, wealth grows through slow accretion, often being taken out of the bone and sinew of the people, to their detriment and ultimate death; in Amer-

Ernest T. Trigg



T. D. Pratt



William A. Redding

Alfred Reeves

FOUR OF THE GUESTS AT THE TRANSPORTATION BANQUET

ica, wealth comes through a marvelous utilization of trained minds, finding new sources of profit, new ways of eliminating waste and a consequent increase in spending power without robbing one human being. As examples of this manner of increasing wealth by the use of God-given intellects that turn obstacle into opportunity, the speaker mentioned the hitherto despised cotton-seed that has become a source of profit and spoke of the development of the great American Desert which became productive after trained minds found out "how to rub out the word, *arid*, and write in the word, *arable*."

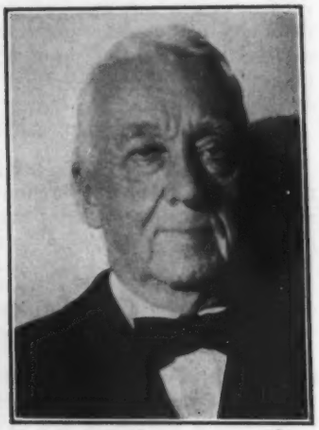
Continuing his remarks on the value of training the mind, Dr. Cattell stressed the importance of all-round development, urging especially the need for intellectual honesty and emphasizing the need and the opportunity for personal service.

Dr. Cattell expressed his belief that the utilization of the individual unit of power as applied to transportation is the greatest solvent of the world's problems and, speaking of the might of the automotive industry, he dwelt upon its place in the world as one of the great bodies of people who are mitigating and ameliorating life.

Vauclain on Coordination

Emphasizing the idea that the automotive industry and the railroads are not competitors in any sense but that each

Dr. E. J. Cattell



S. M. Vauclain

has a definite work, Toastmaster Masury introduced Samuel M. Vauclain, president of the Baldwin Locomotive Works, with the statement that Mr. Vauclain would tell the automotive men how they could coordinate with the railroads better than in the past. Mr. Masury also stressed the thought that each form of transportation has its own function and its own place and expressed the belief that better coordination would be profitable to all. The inspiring and interesting talk given by Mr. Vauclain will appear in an early issue of The Journal. A brief abstract of his remarks follows.

Characterizing himself as being not only a locomotive man but also an electromotive and even an automotive man, Mr. Vauclain spoke of the growth of the industry with which he is connected, attributing its steady development to its willingness to recognize the ideas of youth. "No industry in the United States can survive," he said, "if it ignores the youthful endeavor of the rising generation."

Before touching upon the automotive situation, Mr. Vauclain traced briefly the industrial developments from 60 years ago, when practically everyone walked and a tallow candle of home manufacture was the best light available, to our own day of automobiles and electric lights. He spoke of the locomotive as the great civilizer and stated that from locomotive to electric work was an easy step and that one did not drive out the other. He then expressed his approval of the internal-combustion engine for driving single power units, saying:

> We don't favor trolley cars as compared with motorbuses because, when something happens to the trolley wire, every car stands still; as for motorbuses and individual machines, if one stops, it stops, and the others go around and the traffic continues.

Continuing his remarks about the internal-combustion engine, Mr. Vauclain spoke about the several thousand gasoline locomotives that his company has produced and also spoke in some detail about the Diesel-electric locomotive. A locomotive of huge horsepower, he said, driven by a Diesel engine, is bound to be serviceable not only in many ways on domestic railroads but in countries where water is a scarcity and where every pound of fuel has to be hauled. At this point Mr. Vauclain drew a comparison between industrial development here and abroad, stating that American industry can enter into competition with any country in the world and show up creditably in the competition.

Automotive Industry Influential

Relative to conditions in the United States, the speaker pointed out the fact that the market in this Country depends mainly upon conditions in the industrial section, that is, the East. This market, he stated, is extending. Growing rapidly in the West, the market is growing twice as rapidly in the East, and it is the automotive industry that is accelerating its growth.

Regarding relations between the automotive industry and the railroads, Mr. Vauclain said that the railroad man instead of questioning the loss of his local passenger-traffic is now looking around for means of encouraging people to send freight to the railroad for far shipments. He declined to go into detail as to the way in which this problem would be solved, but believed that the solution would be satisfactorily reached with mutual advantage. Mr. Vauclain then spoke of the benefits of the automobile to this Country, expressing the opinion that it has saved us from a revolution. The cheap automobile, being within the reach of practically everyone and increasing the radius of life of the average working man from 1 to 150 miles, has become a powerful factor of education and recreation, with a consequent tendency to keep everyone occupied and everyone happy.

Concerning the traffic situation, Mr. Vauclain mentioned the advisability of widening city streets by putting the trolley car under ground and using the surface for separate motor-driven vehicles of all kinds, and expressed the opinion that a law prescribing a horseless zone in all our cities would be a great step in advancement.

Committees Deserve Credit

At the conclusion of Mr. Vauclain's address, President Horning took occasion to thank the speakers for their splendid talks. He also complimented Chairman Herrington and the Transportation Meeting Committee for the success of the banquet and thanked Chairman Guernsey of the Pennsylvania Section for the assistance given by the Section, particularly by the local Reception Committee.

In addition to the music by Oppenheim's orchestra, special entertainment was furnished by a quartet. This enjoyable feature was due to the efforts of A. K. Brumbaugh, of the Autocar Co., who showed his usual skill and good taste in these arrangements.

Souvenirs were presented by the Pennsylvania Section to those who registered for the banquet. An attractive little leather-covered notebook made a most acceptable gift, the name of each recipient being printed on his book in gold letters. To the members of the Pennsylvania Section who planned and executed this delightful surprise are due the thanks of the Society for their part in making the Automotive Transportation Banquet a most enjoyable occasion.

COACH OPERATING EXPERIENCES TOLD

Advantages of Gas-Electric and Six-Wheel Coaches at Philadelphia and Detroit

In the presence of about 300 members and guests assembled for the Saturday morning motorcoach operation session of the Automotive Transportation Meeting, Chairman A. J.

Scaife opened the session with the remark that he had attended all Society national meetings sessions since 1912, and he did not remember any that had greater interest or at which the subjects were presented in such an excellent way as at the previous sessions of the Transportation Meeting. As proved to be the case later, the concluding session of the meeting did not differ from Friday's sessions in this respect. The Chairman also said that a report of the Department of Commerce, just issued, showed that in 1923 the automotive industry was the largest manufacturing industry in the Country, and without any doubt it is holding its place in 1925. The commercial vehicle branch of the industry was valued at $40,000,000 in 1921 and 2 years later was valued at $300,000,000.

Highly interesting papers, followed by extended discussion, were presented by R. Harlan Horton, president of the Philadelphia Rural Transit Co., on the very successful operation of the company's fleet of 130 gasoline-electric motorcoaches; by William P. Parker, who presented a paper by W. F. Evans describing the success of the Detroit Motorbus Co. with the use of six-wheel coaches, and by Brigadier-Gen.

R. H. Horton

A. J. Scaife

Albert C. Dalton, of the Motor Transport Division of the Quartermaster Corps, who narrated most entertainingly the sudden change in the attitude of the Army staff at the time of the Mexican border campaign toward the substitution of motor transport for the time-honored transport by mule, and told of the proposed motor-vehicle replacement program of the Army.

Gasoline-Electric Motorcoach Operation

> In the gas-electric bus there has been substituted for the clutch, transmission and differential, a generator, controller and two electric motors, producing a vehicle unmatched for ease of control, rapid and smooth acceleration, and quiet operation. That is the story of the electric drive in a nutshell.

Thus Mr. Horton summarized the advantages of this type of motorcoach in his paper describing the operation of 130 gasoline-electric single and double-deck coaches that have been placed in service by the Philadelphia Rural Transit Co., a subsidiary of the Philadelphia Rapid Transit Co., since last June. Seventy more are to be delivered on the initial order.

The fundamental differences between the electric and the mechanical drive have affected every phase of operation to a very great extent, he said, and he asserted that he knew of no instance in which a fleet of motorcoaches of such size had been placed in operation and given as dependable service with as little trouble as his company had experienced. These automotive coaches are the safest so far devised, said Mr. Horton, whose paper is printed in full in another part of this issue of The Journal.

He emphasized the smooth and rapid acceleration, the concentration of the driver's attention on the road rather than on gear-shift levers, the enclosed platforms and stairways, the reduction of skidding due to the independent drive to the two rear-wheels, and the electric braking in an emergency as factors of safety to passengers. He also spoke of the greater reliability and lesser maintenance as compared with mechanical-drive coaches and said that in one garage the company has established the practice of making inspections after every 4000 miles, which is a first step toward an even longer period between inspections. He said that marked economy in operation has been noticed although the vehicles have not been in operation long enough for him to present detailed cost data, but intimated that later the company will have some very interesting data to present. Gasoline consumption has been decreasing month by month as the coaches have been broken-in and the drivers have become better trained. In preliminary tests the gasoline engine made 20 per cent fewer revolutions per minute than a duplicate engine in a mechanical-drive coach. Thus, wear on the engine is decreased. The electric motors and the generator require very little more attention than oiling and greasing. Faster running-schedules have been possible, said Mr. Horton, not because of higher running-speed, but because of the rapid and smooth acceleration.

William P. Parker

General A. C. Dalton

Six-Wheel Suspension Lowers Costs

Lower maintenance and liability costs are two outstanding advantages of the six-wheel suspension for motorcoaches from the operator's standpoint, as determined by 1 year's experience in the operation of a fleet of such vehicles by the Detroit Motorbus Co., according to a paper by W. F. Evans, president of the company, which, in the absence of the author, was read by Mr. Parker. A tremendous future for the six-wheel suspension for both motorcoaches and heavy-

N. C. Eddy

F. R. Fageol

duty trucks is seen by the officials of the company, which has been operating coaches in Detroit for 5½ years.

After operating solid-tired coaches for 2 years, the company came to the conviction that it would have to adopt pneumatic tires because the public was showing a tendency to react against the hard-riding solid-tire vehicles and also because the company wished to avoid criticism in the matter of damage to the pavements and to reduce operating costs through reduction of vibration. But the use of pneumatic tires on the dual wheels seemed impractical and the multi-wheel vehicle that was brought to the attention of the company while it was studying the matter appealed to it as offering a solution of its problem. Finally, a fleet of 37 six-wheel coaches was placed in service in October and November, 1924. They are double-deck vehicles with a capacity of 60 passengers and have a total weight of 22,000 lb. with passengers and crew.

After a year's operation of this type of coach, the company feels proud of its part in proving the advantages of the six-

BOYD V. EVANS

J. B. WHITE

wheel principle, which it believes represents a distinct advance in the construction of heavy-duty vehicles. The coaches have demonstrated superior tractive ability and non-skid properties, giving passengers a sense of greater security, are safer, have only 17 lb. of weight per square inch of service-brake area as compared with 24 lb. in the dual-tire coaches, and have less rear-spring deflection, so that they ride practically level under all load conditions.

Running schedules can be maintained better because of the superior traction, and damage to bodies is avoided. It is planned to reduce the wheel-housing obstruction by widening the tread and using a housing of heavy material which will be secured directly to the frame of the chassis.

In his introductory remarks prior to reading Mr. Evans's paper, Mr. Parker stated that the Detroit Motorbus Co. operates about 275 motorcoaches, of which 60 are six-wheel vehicles of several types, and will shortly add 80 more of six-wheel construction. The complete paper will be found on subsequent pages of this number of THE JOURNAL.

FROM ARMY MULE TO MOTOR TRUCK

The six-wheel truck is, from the military standpoint, the greatest single development the Army has had, because the future war will be a war of movement, said General Dalton, whose address followed the presentation of Mr. Evans's paper. There will be no more stabilized positions such as there were during the World War. The airplane will make any stabilized position absolutely untenable, so that artillery placed in the night will have to be moved the next day. Already we have movable gun-mounts for the 75-mm. and the 4-in. guns and development will keep on until movable mounts for large heavy ordnance are provided. Even the great fixed guns in our fortifications will have to be mounted on railroad carriages or on automotive mounts. The crawler type of tractor is too slow and the multi-wheel truck seems to him, he said, to offer the only solution. When it comes to a highway it will be able to speed-up to from 18 to 35 m.p.h., carrying heavy guns. When it is to go into position, it will run off the road and all of the wheels will drive and will bear their share of the weight.

The General, who was chief of transportation of the Army for 2½ years, talked interestingly of the first real awakening of the Army staff to the necessity for motor transport during the Mexican border campaign, when Gen. Tasker H. Bliss, after personally looking over the situation, made a recommendation in 15 words to the War Department for the purchase of 100 motor trucks and Secretary of War Baker approved it. Only a year previously, in 1915, one of the highest ranking and most powerful officials in the War Department made the statement that he could see no change necessary in the standard animal transportation for the Army.

Notwithstanding the experience with automotive equipment in the World War, no particular interest is manifested now in the Army as to motor vehicles, said General Dalton, who is himself keenly interested in the subject and who told how, by a graphic chart, a copy of which was displayed at the meeting, he had succeeded, by ridicule of the mule and its vulnerability, in making more of an impression than by any amount of written argument. He and some other officers have been trying to arrange a program for the replacement of the vehicles in the Army and, so far as he has any influence, he said, an attempt will be made, first, to determine the mechanical, road and other requirements and then to purchase motor vehicles of standard commercial types that will meet them. Minimum and maximum requirements for each type would be fixed and the vehicles to meet the requirements would be purchased from commercial companies. To meet the maintenance and repair problem, all trucks of one make would be assigned to a distinct territory.

If we go into a war again, he said, we must have hundreds of thousands of vehicles, and by the foregoing procedure the Army would have the entire automotive production interests of America behind its program. In time of peace, the Army will need from 6000 to 8000 automobiles and from 25,000 to 30,000 motor trucks, and, by allocating them by makes to separate territories, would have the benefit of the experience and the facilities of the builders' service-stations. After the first 2 years, a normal replacement of perhaps 20 per cent would be required each year.

One of the problems that has impressed him, said General Dalton, is the great necessity for National highways. The National system, comprising about 70,000 miles, when completed in about 9 years, will be one-third greater than the national highways of all the other nations of the world combined. In military transport, the highway is 50 per cent and the vehicle is 50 per cent. Motor transport is here, it is a part of a great transportation system and it is a necessary link in the chain.

MUCH DISCUSSION ON GAS-ELECTRIC MOTORCOACHES

Written discussion on Mr. Horton's paper, questioning mildly the claims for superiority of the electric drive over the mechanical drive, as made by the author, was presented by H. D. Church, of the White Motor Co.; A. E. Hutt, of the Westchester County Bus System; and Charles Froesch, of the International Motor Co., after which Mr. Horton answered many questions from the floor. In his replies he said that the possible use of pneumatic tires on future motorcoaches depends wholly upon whether the public is willing to pay for them. The company's tire expense for the single-deck coaches on which pneumatic tires are used is very much greater than for the double-deck vehicles that are equipped with solid tires. The generator is differentially wound and the output increases as the engine speed increases, thus providing more current for the electric motors, so the speed of the vehicle is controlled entirely by feeding more or less fuel to the engine. The engine cannot be accelerated too fast nor stalled by too quick depression of the control pedal. He said that he did not know what the average life of the brake-linings was, as none have worn out. Some of the company's mechanically driven coaches have been run 60,000 miles

B. J. LEMON

C. M. MCCREERY

without a change of brake-lining. Regarding the electrical efficiency of the electric drive, he said that the designers claimed an efficiency of 75 per cent. To other questions he replied that the outstanding advantage of the six-cylinder engine for large motorcoaches is its quick response and the more rapid acceleration obtained; that the vehicles accelerate at a rate of about 2 m.p.h. per sec. up to 10 m.p.h. for the double-deck vehicle and slightly more for the single-deck type, and that the single-deck motorcoach weighs about 16,000 lb. and the double-deck vehicle about 17,000 lb.

C. O. Guernsey, of the J. G. Brill Co., told of efficiency tests that were made several years ago of four-speed transmissions and final drive. The tests showed higher efficiency at some of the lower speeds than on direct drive, he said, probably because of the lower efficiency of the worm gear at its lower speed, but with spur-gear drive to the axle the efficiency at the different speeds was fairly constant. The tests showed an efficiency of 96 per cent with the spur-gear drive. Too much attention should not be paid, he said, to the efficiency of the electric drive as it relates to gasoline consumption, because the electric drive makes possible so many other savings in the powerplant.

DISCUSSION ON SIX-WHEEL SUSPENSION

Questions on Mr. Evans's paper were answered by Mr. Parker and Boyd Evans, brother of the author. Where it has been possible to compare maintenance costs of the six-wheel motorcoaches with the dual-wheel vehicles under corresponding operating-conditions for the same period, said Mr. Parker, the comparison has been entirely in favor of the former. The six-wheel suspension contributes more to ease of riding and reduction of skidding than the use of pneumatic tires on the motorcoaches. While pneumatic tires cost more than solid, the total maintenance of the vehicle is less. Mr. Evans said that the operating company is getting an average of about 19,000 miles from the pneumatic tires and that no difference in wear of the front and rear tires was noticed. The company is working into larger tire sizes and some of the new single-deck motorcoaches that are coming through have balloon-tire equipment. A change of tire on a six-wheel motorcoach requires about 5 min., he said, and a delay of only 18 min. occurs from the time the emergency truck leaves the garage where it is located until the new tire is in place on the wheel, and the motorcoach is ready to proceed.

Burton J. Lemon, of the United States Rubber Co., told of some noise measurements made with an audiometer in motorcoaches and street-cars. The six-wheel motorcoaches, running in second speed, registered from 35 to 41 points on the dial and the dual solid-tire vehicles registered between 50 and 60. As compared with these, the noise in Detroit street-cars, with the windows closed, registered not more than 25 points, and the noisiest places that could be found, in his company's blacksmith shop and in the power generation room, ran the pointer up to about 75.

Mr. Evans said in answer to a question that, although he had no exact figures on the relative stopping ability of the six-wheel as compared with the four-wheel motorcoach, the driver of the former could practically "stand it on its nose" on a slippery street without evidence of skidding, whereas it would be almost suicidal to attempt to make the same stop with dual solid tires.

A. W. S. Herrington, of the Motor Transport Division of the Quartermaster Corps, stated that he had just received a report on the first 10,000 miles of operation of the six-wheel motor trucks operated by the Marine Corps between Broadkill Base and Philadelphia, and the chief fact noted was that the drivers reported that the truck was the most satisfactory to drive of anything the Corps had ever had, and that on the hilly road between Philadelphia and Baltimore a higher rate of speed could be maintained than with any other trucks used by the Marine Corps or the Army. He believed, he said, that the six-wheel development will be confined to vehicles of the larger sizes, about 4 tons.

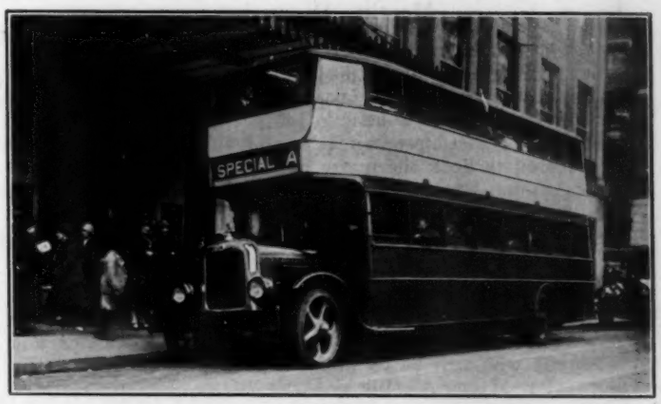
Chester M. McCreery, of the Six-Wheel Co., said that he thought that eventually pneumatic tires would be used almost entirely with the six-wheel design and that the effect of tires on the pavements and the comfort of the passengers must be taken into consideration. A practical way should be developed for using pneumatic tires on double-deck motorcoaches.

VISIT MOTORCOACH SERVICE-STATION

Philadelphia Rural Transit Co. Depot Inspected by Many Who Attended Meeting

Two double-deck motorcoach loads of Society members attending the Automotive Transportation Meeting, numbering 125, were transported from the Benjamin Frankin Hotel at 2:30 p. m. on Saturday to the operating and service-station of the Philadelphia Rural Transit Co., a subsidiary of the Philadelphia Rapid Transit Co., located in North Philadelphia, and were shown through the plant by four representatives of the company. The trip was arranged by C. O. Guernsey, of the J. G. Brill Co., through the courtesy of R. H. Horton, president of the transit company.

After a run of about 20 min. in the gasoline-electric motorcoaches, with the operation of which Mr. Horton had dealt in his address at the morning session and whose smooth acceleration was particularly noted by the members during the ride, they alighted in the garage, where many of the new single and double-deck motorcoaches were ranged along the wall ready to go out on routes. Starting in the employes' reading and waiting room, with the executive and accounting



LOADING THE MOTORCOACHES FOR THE INSPECTION VISIT TO THE SERVICE-STATION OF THE PHILADELPHIA RURAL TRANSIT CO.

The Concluding Feature of the Automotive Transportation Meeting Was Enjoyed by Approximately 125 Members and Guests. Two Double-Deck Motorcoaches with Gasoline-Electric Drive, Provided by R. H. Horton, President of the Transit Company, Transported the Party to the Depot in North Philadelphia and Brought Them Back to the Hotel at the Conclusion of the Visit

offices at one end, the visitors were shown the vehicles in the plant, which included two new four-wheel-drive Walter tractor snowplows, each carrying a plow in front and another back of the front wheels and having an open-bed body, and several new single-deck de luxe motorcoaches for use on the Philadelphia-to-New York City route that is now in operation, the Philadelphia-to-City of Washington run that was inaugurated on Nov. 14, the day of the visit, and the Philadelphia-to-Atlantic City service that is to be started.

The visitors viewed with interest the several concrete inspection and repair pits in which the mechanics were at work on some of the motorcoaches and in which they were able to stand upright and work conveniently on the under-mechanism of the vehicles overhead. The quiet almost vibrationless running of the engines in the motorcoaches was very noticeable. The battery room, where the starting and lighting batteries were being inspected, overhauled and charged, and the tire-storage room were also visited. The single-deck motorcoaches are equipped with giant pneumatic tires mounted on disc wheels, while the tire equipment for the double-deck vehicles is dual solid tires. The small amount of repair work that was going on for a fleet of 130 motorcoaches and the slight provision in the way of equipment for such work were noteworthy as indicating that the company has not had occasion to do much along this line.

At the conclusion of the visit, the special coaches that carried the party were lined up in front of the garage and photographed, after which the visitors reembarked and were driven back to the hotel in time to catch the early evening trains out of town.

ANNUAL DINNER PLANS CRYSTALLIZE

Chairman Batt Arranging for Attractive Entertainment and Dinner Speakers

Thursday night of Automobile Show Week in New York City has for years been reserved by the automotive engineers for the Annual Dinner of the Society. In fact, this gathering has achieved a reputation among the automotive fraternity that is sufficiently widespread to require no elaboration.

A detailed announcement of the features of the Dinner, together with applications for reservations, will be circulated soon.

Date, Jan. 14, 1926; place, Hotel Astor, New York City.

ARE SUPERCHARGERS COMING?

This and Many Other Questions Scheduled for Annual Meeting Discussion

One who should know was recently heard to predict that in the near future the great majority of the automobiles produced in this Country will be equipped with some form of supercharger. Do you believe it? Regardless of whether or not this prediction coincides with your thought, you will be interested to hear the many phases of the topic discussed at the Annual Meeting that is to be held in Detroit, Jan. 26 to 29.

Steam Cooling

This is only one of many intensely interesting and important features that the Meetings Committee has provided for the largest gathering of automotive engineers during the year. Steam cooling, for example, has many advocates and antagonists who will be on hand to justify their attitude by presentation of engineering data.

Aeronautics

Judging from the Society's experience at the recent Aeronautic Meeting, great interest will be taken in the Annual Meeting Session at which persons who have figured prominently in aeronautic activities will present papers dealing with both heavier and lighter-than-air craft.

Motorcoaches

Have you ever approached extinction by asphyxiation while riding in a motorcoach? Most people have and will welcome the consideration of heating and ventilating of motorcoach bodies that will occupy a prominent part of an Annual Meeting session. The development of motorcoaches will also be discussed in detail by an engineer who is considered preeminent among the pioneers in this line of effort.

Engines, Fuels and Lubricants

As for engines, papers dealing with the more recent developments, including those of the sleeve-valve and solid-fuel-injection type, will be presented.

The session on Fuel Utilization and Lubrication will bring to light the results of extensive work in the direct lubrication of internal-combustion engines and along other lines of equal importance. The new anti-knock fuels will be discussed. Do you know what they are, how they are made, and what they can do?

Do Your Brakes Squeal?

Eights may come and fours may go but brakes squeal on forever. A specialist on brakes will tell why they squeal and how this annoying difficulty may be remedied. Much additional information pertaining to brakes and brake-lining will be included in one session.

Color Harmony and Other Topics

Color appeal and harmony undoubtedly play an important part in determining the attractiveness of automotive vehicles. A well-known color expert will explain the intricacies of color application, at a Body Session, and a distinguished artist will tell why orange combines better with black than with cerise. In other words, he will point out the essentials in the problem of color harmony in body finishes.

Of course a Research Session will be held and the topics of Production and Headlighting will be among those present, but why tell the whole story at one sitting? Watch for further announcements in The Journal and in the *Meetings Bulletins!*

STANDING ROOM ONLY

Full House Expected at Dance Carnival during Annual Meeting Week

A group of experts, loyal and true, headed by Walter R. Flannery is making preparations that should assure the 1926 Dance Carnival of incomparable success. L. Clayton Hill, in charge of entertainment, has promised to beat the unbeatable and to furnish a program that will make an indelible impression upon those who attend. It is safe to say that the Committee for the 1926 Carnival, the chief social attraction of the Annual Meeting, will stage an affair that will, without sacrificing appropriate orderliness, provide refreshing relaxation and acceptable enjoyment for all.

Remember the date, Jan. 27, and the place, Oriole Terrace, Detroit. Announcements and applications for reservations will be circulated in the near future.

WAR NOW BETWEEN STREET CURBS

Traffic Control Described at Meeting of Northern California Section

The new warfare in this Country is waged between the street curbs, Capt. Henry Gleason, of the Traffic Department of the San Francisco Police Department, told 75 or more members of the new Northern California Section at its meeting at the Engineers Club in San Francisco after a dinner on the evening of Nov. 24.

The San Francisco Police Department is now divided into a Detective Bureau that functions behind the curb lines and a Traffic Department that operates between the curbs, he

said. When a person goes home, it is the burglar of whom he must beware, but when he leaves home he is imperiled by street-cars and motor vehicles when he crosses the street.

Captain Gleason made a very interesting address on the control of traffic in the city and laid stress on the need for nationwide uniformity or standardization of traffic regulations.

Work that the State is doing in the regulation of traffic on the highways was explained by William H. Marsh, chief of the California Division of Motor Vehicles, who tendered the thanks of his division to the corporations and fleet operators for their splendid cooperation with the authorities and said that if individual drivers would cooperate to the same extent the problem of State traffic would be very much simplified.

Registrations of motor vehicles in the State have increased from 163,000 in 1915 to 1,400,000 at the present time, he said. Records are kept of licenses by engine number, alphabetically by names and by titles. Maximum allowable weights and speeds for commercial vehicles were given by the speaker.

Too much legislation is enacted, said Mr. Marsh, after the conclusion of whose address a very interesting discussion of the subject of traffic control was participated in by the members in attendance.

Chairman E. C. Wood, who presided, opened the meeting with preliminary remarks about the traffic conditions in California and in the city of San Francisco.

Secretary W. S. Crowell reports that the next meeting of the Section, to be held in the Engineers Club the evening of Dec. 29, will be addressed by Harold Jarvis on the problems of fleet operators.

MANY NEW AIRLINES STARTING

Stout and Van Zandt Tell Indiana Section of World's Progress in Aviation

Commercial airlines are being started all over the Country and next year several routes will be linked into a transcontinental commercial air service, W. B. Stout, of the airplane division of the Ford Motor Co., told members of the Indiana Section at their monthly meeting on the evening of Nov. 12 at the Severin Hotel, Indianapolis. He also said that the division began building an airplane 4 months ago that will be driven by three air-cooled engines.

W. B. Stout

J. P. Van Zandt

After telling of the promotional and development stages of his organization and the starting of the Ford airlines to Chicago and Cleveland, illustrating his remarks with moving pictures, Mr. Stout said that an airline from Los Angeles to Salt Lake City is being started by the Western Air Express, which next year will extend the line to Dallas, Tex., and that the Finance Air Transportation is starting a line from Chicago to Dallas, so that a continuous airline from Los Angeles to Chicago will be in operation. The Ford line from Chicago to Detroit may be extended to Buffalo, New York City, New Haven, Conn., and Boston, thus providing a transcontinental route. In the spring a passenger service between Detroit and Cleveland, operating on a 1-hr. schedule, will be in operation in charge of George Holley, of Detroit. A large number of lines are being projected in Florida, he said, and his company is sending airplanes down there as fast as they can be built. Transportation of freight and passengers by air offers the only solution of the great traffic congestion in Florida, and the relief by airplane is being brought about by the safety and relatively low cost of commercial aviation that have been demonstrated.

Germany Leading Europe

While commercial aviation has been almost at a standstill in recent years in the United States, Europe has a network

SCHEDULE OF SECTIONS MEETINGS

DECEMBER

2—Milwaukee Section—Application of Air-Cleaners to Internal-Combustion Engines—H. L. Mills
3—Detroit Section—Steam Cooling—Herbert C. Harrison
4—New England Section—Profit-Paying Airplanes—Charles G. Peterson
8—Pennsylvania Section—Automotive Steels—Dr. B. H. Delong. Inspection trip through Carpenter Steel Co.
10—Indiana Section—High Duty Engines—Fred S. Duesenberg. Added talks by experts from McCook Field and the General Electric Co.
11—Southern California Section—Gasoline, Its Manufacture and Utilization—R. E. Haylett and J. B. Terry
Washington Section—Steam Cooling—A. G. Herreshoff
14—Cleveland Section—Gasoline-Electric Drive for Motorcoaches—J. C. Thirlwall and E. M. Fraser
15—Buffalo Section—Transportation Service—Ernest Murphy
16—Dayton Section—The Organization and Operation of the General Motors Proving Ground—O. T. Kreusser
17—Detroit Section—Cylinder Lapping (Both sides of the question)—Members of factory organizations of Hupp, Ford, Continental, Packard, Paige-Detroit, Chrysler, Dodge, White, and Wilson Foundry & Machine Co.
Metropolitan Section
18—Chicago Section—Present-Day High-Efficiency Engines—Fred S. Duesenberg
29—Northern California Section—Problems of Fleet Operation—Harold Jarvis

of air transportation lines in almost every European country and into Africa, said J. Parker Van Zandt, who illustrated his talk with lantern slides of charts showing data of the performance of the European routes and the United States Air Mail Service. In the last 2 years Germany has been leading in the number of routes and in miles flown.

No nation or combination of nations can land an offensive force on the shores of the United States, declared E. S. Gorrell, who talked of military aviation and cautioned against uninformed criticism of the Army's policy of National defense, which is a problem that can be handled only by those who are expert in that line, he said. He urged that the subject be left to the strategists and other students of defense problems, saying that it cannot be thought that the decisions of all of the Presidents since 1917, and of the Cabinet officers, the members of three Congresses and the Army and Navy staffs have all been wrong.

Many Commercial Airline Possibilities

Answering questions by F. E. Moskovics, Mr. Stout said that the cost per pound of carrying freight on the Detroit-to-Chicago line, including deliveries at both ends, is about 13 cents, while to Cleveland it is 10 cents. He was convinced, he said, that the air-cooled engine is the future engine for commercial airplanes, as most of the forced landings are due to cooling troubles; that the real future of passenger and freight transportation by air lies in the long routes where the rail routes are roundabout, and mentioned the bee-line air route from Detroit to Minneapolis across Lake Michigan that can be covered in 6 hr. with a three-engine airplane, as one of the thousands of promising airlines. The cost of operating such an airplane was given as $60 per hr. He preferred the air-cooled engine because of its reliability and also because of the decrease in weight, and asserted that each pound of airplane weight saved on the Chicago-to-Detroit route means an increase in the receipts of 20 cents per trip. The air-cooled engine also requires less maintenance.

Regarding airports, Mr. Van Zandt, in answer to a question by Chairman G. T. Briggs, said that the ideal landing-field is one that is very accessible from the business center of a city, 80 to 100 acres in extent, with a clear east-and-west runway 500 to 1000 ft. long, and without surrounding obstructions. The Department of Commerce is gathering facts about municipal landing-fields that have been constructed and hopes to have the data available within a few weeks for cities that are contemplating providing such fields. A present law forbids the selling of supplies, equipment or service at Army and Navy landing-fields, he said, but the Department of Commerce has recommended to Congress that the law be changed to permit of reasonable use of all Government fields for commercial aviation.

SPECTACULAR ARMY-VEHICLE TESTS

Washington Section Hears Very Interesting Talk on Ordnance Proving Ground Tests

Extraordinary field tests through which trucks, tractors and tanks are put by the Ordnance Department of the Army at the Aberdeen Proving Ground were described and copiously illustrated with moving pictures and lantern slides by Capt. J. K. Christmas at the monthly meeting of the Washington Section which was held at the Cosmos Club, City of Washington, on the evening of Nov. 20. The subject was so completely covered by the speaker that no discussion followed his remarks. Chairman S. W. Sparrow presided.

Problems confronting the Ordnance Department at present are to (*a*) obtain good tractors or prime movers of three sizes for hauling guns weighing 4000, 10,000 and 30,000 lb.; (*b*) develop a good medium-size tank weighing about 15 tons and a small tank weighing about 5 or 6 tons; (*c*) develop a cross-country truck or cargo carrier to haul ammunition up to motorized batteries or units; and (*d*) develop corps and army automotive gun-carriages, such as tractors on which guns are mounted. The chief difficulty encountered with the tractors and tanks is the short life of the tracks, while, with the cross-country truck, the question of securing adequate traction with very low ground-pressure is the main obstacle, said Captain Christmas.

The automotive testing consists of subjecting vehicles that are sent to the Proving Ground to complete, severe and exhaustive tests in accordance with programs issued by the Chief of Ordnance and submitting full reports on the results. In addition, many special laboratory and outdoor tests are made to secure engineering and design data from which general principles can be laid down. The general aim is to develop and procure for the infantry, the field artillery and the air service satisfactory improved tractors, tanks, automotive gun-carriages and cross-country vehicles that will meet the general tactical and strategical requirements that are laid down by the General Staff and the using services.

The Proving Ground tests are, in the main, essentially operating and performance tests under conditions that approximate service conditions as nearly as possible; hence the tractors are driven through soft earth, snow and ice, across sunken roads, over obstacles and on steep gradients and haul guns of various sizes. Tanks are put through similar tests, with the exception of hauling guns, and the cross-country trucks are tested in soft ground, on grades and so on. One lantern slide showed a truck of the six-wheel type descending a 25-deg. slope with the front wheels on the level, illustrating the equalization of the load on the four rear wheels. Another showed a tractor breaking its way through 5 in. of ice. Nearly 50 slides were thrown on the screen.

Of particular interest was the special testing apparatus that was shown and described by Captain Christmas, which included a 300-hp. electric dynamometer for making block tests and a recording traction dynamometer mounted on a two-wheel cart fitted with pneumatic tires, which is attached between a tractor and a gun-carriage to be drawn. Results to date show mean values of tractive resistance for average typical artillery vehicles fitted with steel-tired large-diameter wheels as follows: on concrete roads, 26 lb. per ton; on ordinary dirt road in summer, 55 lb.; across fields in summer, 120 lb. and in loose sand, 390 lb. per ton.

THE SECOND LINE OF DEFENSE

Commercial Aviation So Called by J. Parker Van Zandt at Buffalo Section

New charts giving statistics and comparisons of commercial aviation throughout the world in the last 5 years, fresh from a meeting of the Committee on Civil Aviation of the Department of Commerce at the City of Washington, were shown for the first time by J. Parker Van Zandt, secretary of the Committee, at the meeting of the Buffalo Section following a dinner at the Hotel Statler in Buffalo on the evening of Nov. 17. The address on the present status of commercial aviation was also illustrated with motion pictures of the inauguration of the Ford airlines and pictures showing landing-fields and commercial airplanes in service in Europe and the United States.

The establishment of an adequate commercial aviation industry in this Country would do away with the problem of providing huge forces of war airplanes, said Mr. Van Zandt. The Government will soon recognize commercial aviation as a second line of defense. European countries already have discovered the significance of civil aviation and are encouraging it by subsidizing air transportation lines. In the 8 years since its inception, commercial aviation has made remarkable strides, he said, outstripping both rail and motor transportation in the rapidity of its development. Transportation by airplane has become so safe, he said, that insurance rates on shipments by airplane are lower than by rail, mainly, however, because the possibility of theft is eliminated.

A bill providing for a basic aviation law is to be presented

to Congress at the next session, Mr. Van Zandt told his hearers, and he urged the construction of landing-fields throughout the Country, saying that cities should provide the air terminals and the Government should take care of the flying and intermediate necessities of commercial aviation. The United States affords better opportunities for development along this line than Europe, because this Country is so large that it permits great freedom of flight without passing over the border of a foreign country.

LATEST PHASES OF ENGINE LUBRICATION

Milwaukee Section Told of Present Oiling Defects and Corrective Measures

Always prominent in the thoughts of automotive engineers, the lubrication of an internal-combustion engine presents continuous interest in that, even now, characteristic and elusive lubrication difficulties exist that largely baffle correction. According to T. E. Coleman, vice-president of the Madison-Kipp Corporation, Madison, Wis., who delivered the paper on Engine Lubrication at the meeting of the Milwaukee Section that was held on Nov. 4 at the Blatz Hotel in Milwaukee, many of these lubrication difficulties still exist because we have expended more energy in correcting diseases of the lubricating system than we have spent in preventing the diseases by original design.

Mr. Coleman thinks that when we pause long enough to analyze what we have been doing in the last few years of study on lubrication, it is irksome to realize that we still have to contend with all the old reliable bugbears such as oil-pumping or over-lubrication, fuel dilution of the oil supply, lubrication failures under certain conditions of engine operation, excessive wear on engine parts and high maintenance costs. He said that all these defects do not exist in all engines; but one or more of them are present in most engines, and all of them, as well as some others, exist in some engines that are produced in large quantity.

Certain requirements of oiling systems are desirable for all types of automotive engine, the important demands being that

(1) The delivery of oil should be automatic
(2) Oil should reach all bearing surfaces immediately upon starting the engine, under all temperature conditions
(3) The quantities of oil fed to the surfaces should be correct, and should be under accessible control
(4) The consumption of oil must be a reasonable quantity
(5) The oiling system should not be permitted to discourage other important desirable features of engine design

Mr. Coleman considered the foregoing requirements in the order listed. Few engines have oiling systems that are not completely automatic, but most recirculating systems fail to carry the lubricant to all surfaces during the first few minutes of engine operation. Feeding correct quantities of oil opens a broad field for discussion. The speaker believes that excessive oil causes as much engine trouble as any other defect in the oiling system; it lessens maximum power, increases fuel consumption, can be charged with creating "ping," increases maintenance costs, and is one of the most damaging agents in destroying the good quality of the oil supply, and he went on to give explanations of these statements.

Variation in Oil Consumption Not Warranted

While it is possible to correct excessive oil-consumption to a certain degree by the careful selection of the proper grades of oil, this is not a positive method because it depends too much on the willingness of the operator in the field. The oiling system should be such that, in the production of a quantity of engines, the builder can feel confident that all these engines will consume a like amount of oil in any given service. The variations in oil consumption due to changes in service are unwarrantable in many cases, and it is often true that the highest total oil-consumption occurs when the engine is doing the least amount of work.

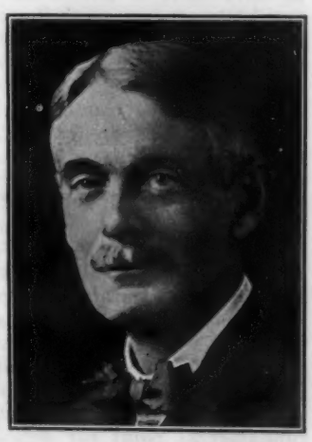
Continuing, Mr. Coleman said further that, if the designer determines to adopt a system that permits greater control of oil consumption, he must plan to feed oil to the pistons of an engine in minute quantities. The oil delivered should be just enough to provide the proper piston-seal, and it should be fresh from the container when it reaches the hot surfaces. The quantity of oil required by an engine can be measured in drops per minute, and an engine that receives oil in such quantities cannot be subject to over-lubrication. Such a system allows the engineer a freedom in design that he cannot have if he adopts a flood system of lubrication. He can determine piston clearances without regard for oil-pumping, and he can work out carburetion and fuel-distribution problems without fear of interference in the fuel charge by excess oil. He finds himself freed of many of the aggravating diseases that he has always had to combat. Mr. Coleman remarked that his statements are founded on good fair test-material or on field experience, and that he expects to present the data in detail in a following paper.

Discussion of the paper centered largely upon the mechanical details and the performance of the oiling system Mr. Coleman advocates. Typical lubricator assemblies were illustrated and described.

An instance of the performance of an oiling system of the foregoing type was cited by J. B. Fisher, chief engineer of the Waukesha Motor Co., who said that, since installing such a lubricator on one of this company's heavy truck-engines 2½ years ago, the oil consumption has remained steady at 1½ pt. of oil per day. A recent examination of this engine showed that the pistons still fit snugly and that very little wear had occurred in 2½ years, during which time the valves had been reground but once. Mr. Fisher said also that if almost any piece of machinery is lubricated properly by fresh oil definitely placed at regular intervals, wear is almost eliminated.

CRANE PROPOSES HEADLIGHT SOLUTION

Method for Adequate Headlights Having Lessened Glare Given Detroit Section



Henry M. Crane

An idea, very much in the why-didn't-somebody - think-of-that-before class according to one newspaper report, was promulgated by H. M. Crane, technical assistant to the president of the General Motors Corporation, at the meeting of the Detroit Section held on Nov. 5. Influenced by the facts that, if one drives a car with headlights full-on he risks unmerciful tongue-lashings from approaching car-drivers and if he switches off the bright lights in response to panicky flicker signals from advancing motorists he has to grope his car along, Mr. Crane, realizing the increasing seriousness of the headlighting problem, has endeavored to minimize its evils. On this occasion, he summarized his plan, his tests and his findings, supplementing his verbal presentation with diagrams and headlighting demonstrations.

In brief, Mr. Crane's suggested scheme of headlighting, after experimentation on his own car with standard equip-

ment consisting of head-lamps having parabolic reflectors and Bausch & Lomb lenses, mounted 36 in. above the road surface and adjusted possibly to a dip of 4 in. in 25 ft., is to rotate the lens in the right head-lamp about 9 deg. in the proper direction to lower the left-hand end of the projecting beam and to raise the right-hand end. A separate switch permits the extinguishment of the left headlight alone. With that headlight extinguished, the regular city driving or parking-light in the low-candlepower bulb furnishes a marker-light for the left side of the car.

When two cars equipped with this system approach each other, the left headlight on each car is either extinguished or else heavily dimmed, no change being made in either the intensity or the direction of the right headlight-beam. The result is that the passing light on the right side of the road, for each car, is maintained at maximum efficiency, while illumination on the leftside of the road is in each case furnished by the approaching car. This reduces glaring effect at least 50 per cent.

The extinguishment of the left headlight produces no apparent decrease in illumination when another car is approaching, as observed by Mr. Crane during many hours of night-driving. He said that the light from this lamp, under normal conditions, is being thrown on a part of the road already lighted by the approaching car and gives no useful result in illumination to offset any glare produced by it. At the same time, the right headlight, due to the angular position of the beam, rarely throws any blinding rays above the wheel-hub of the oncoming vehicle and maintains a long-distance beam on the right side of the road, where it is most necessary. The advantage of these two points is most noticeable on heavily crowned roads, although it is present to a great degree under all conditions.

Mr. Crane stated that the method he advocates is open to the objection of a necessity for some control over the direction of headlight beams of considerable power. He believes it true that this control need not be as accurate as is required by the ordinary fixed-beam system; but said that full cooperation by car users, either voluntary or under the stress of rigid enforcement, is needed for the successful accomplishment of satisfactory results, with this proposed system or with any other system. In the case of second-hand cars, a tremendous problem exists for officials who attempt to enforce a headlight law. For this reason, Mr. Crane suggests the possibility of using diffused light produced by large-diameter frosted-bulbs on cars of low price and presumably moderate speed. He said that this is the only foolproof system of which he knows, regarding glare, and if set up with an arrangement to dim the left headlight, it can be made entirely satisfactory. Regarding the bulb equipment for headlights of the present conventional construction, he suggests that these bulbs be frosted over that part of the surface through which the direct rays from the filament pass out through the headlight glass.

The second paper, by W. D'A. Ryan, was one that he had read at a previous meeting of the Metropolitan Section and was entitled Specifications for Headlights; it is printed in this issue of THE JOURNAL. Supplementing R. N. Falge's delivery of the third paper, relating to Improvements in Headlighting, he said that one object of using a frosted bulb is to eliminate so-called filament reflection, making special reference to bulbs containing two filaments.

Commenting upon the feasibility of the procedure proposed by Mr. Crane, attention was called by T. J. Litle, Jr., to the difficulties of maintaining headlights in proper adjustment and of enforcing such regulations as may be devised for operating headlights. J. H. Hunt stated that the fundamental point for decision is whether a headlight device that can be controlled by the driver is desirable and, if so, suggested the possibility that the beam pattern of the left light be changed so as to increase the amount of light down the road and to compensate for the decrease of light from the right headlight because its beam is set at an angle. Among the other points brought out in the discussion, the liability to failure of any device because of the individual's human vagaries was emphasized.

HEADLIGHTS ASSUME MAJOR IMPORTANCE

Increased Headlight-Problem-Research Activity Indicated at Chicago Section

Numerous phases of the serious problem of suitable headlights for automobiles and of enforcement provisions and procedure for regulation were presented and discussed at the meeting of the Chicago Section held on Nov. 20, some of the points involved being analyzed more completely than at previous Section meetings in New York City and in Detroit which featured the general subject of head-lamp illumination. H. M. Crane, technical assistant to the president of the General Motors Corporation, delivered the paper, enlarging upon his previous one entitled A Possible Solution of the Headlight Problem, presented on Nov. 5 to the Detroit Section.

With reference to a news item in the *Detroit Free Press* of Oct. 23, dated at Grand Rapids and giving information concerning the conference on the State uniform traffic-code being held at that time, to the effect that "A resolution was adopted asking the legislature to standardize headlights for motor vehicles," Mr. Crane asked whether automotive engineers feel sure that they know what such standardization ought to be and whether they are confident that, if standardization follows the lines of what has been done in the East, the result will be satisfactory. He supported his critical attitude toward the present headlighting situation by making various constructive suggestions.

A brief summary of a possible solution of the headlight problem submitted by Mr. Crane is given in the account of the Detroit Section meeting of Nov. 5, which appears elsewhere in this issue of THE JOURNAL. He believes that if we assume some action by the driver of a car that results in a modification of the light distribution from his headlights when meeting an approaching car, we shall be able to provide a much better driving-light, coupled with a much less objectionable glare, than it is possible to provide with fixed equipment based on the present standard specifications; and that the public as a whole can be trusted to use in a considerate manner such equipment as he outlined.

This third recent meeting at which the subject of headlighting was given prominence indicates a realization on the part of the automotive industry of the necessity for focusing attention on and solving this problem. Mr. Crane said that the volume of complaints regarding poor lighting-equipment for cars is increasing daily and that engineers cannot evade their share of responsibility for a condition that all admit is unsatisfactory. He is convinced that we never will arrive at a satisfactory result except by a concerted effort of all who have a contributing influence in any way. This makes it necessary to add to the rank and file of those who have been deliberating on the subject more representatives of the builders of cars who control the quality of lighting equipment that is supplied the public. In the long run the public will get what it demands in the way of lighting equipment.

TYPES OF ROAD AND THEIR PERMANENCY

Southern California Section Considers Road Construction and Disintegration

Competent engineers of the Pacific coast district presented papers at the successful meeting of the Southern California Section that was held on Nov. 6 in Los Angeles. Following the dinner, which was attended by 78 members and guests, the subject of Road Construction and Destruction commanded the attention of those present at the meeting.

The paper by J. F. Jellick, engineer of the Portland Cement Association, was presented by D. L. Holmes of that Association. Asphaltic Concrete Roads was the topic chosen by C. P. Jensen, county engineer of Fresno County, Cal., who

explained the latest developments in this type of road construction. In his opinion, asphaltic concrete roads are less expensive than other types in first cost and in upkeep and are far more durable. The merits and demerits of the various types of road prevalent in Los Angeles were enumerated and commented upon by R. W. Stewart, deputy city engineer of Los Angeles. Additional important considerations relating to the general subject were developed during the course of the animated discussion that followed the presentation of the papers.

LUBRICATION VISUALIZED

Oil-Film in Action and Air Lubrication Demonstrated at Metropolitan Section

If grooves of one kind or another are put on tire treads to *prevent* skidding on a slippery pavement, why are grooves put in a bearing to *make* the journal skid on it? This question was asked by H. A. Howarth, of the Kingsbury Machine Works, who presented a paper on Non-Skid Tires and Oil Grooves before the regular monthly meeting of the Metropolitan Section held at the Hotel Empire, New York City, on Nov. 19.

The obvious answer, said Mr. Howarth, is that oil grooves should not be provided in the loaded side of a bearing, because oil grooves are channels through which the oil pressures in the film are relieved. This relief of pressure thins the film and makes the bearing run hotter than it otherwise would. By an electric light connected so that the circuit was opened when the bearing surfaces became separated while in motion, Mr. Howarth also demonstrated how a bearing can be lubricated by air.

As another feature of this interesting program, D. P. Barnard, 4th, of the Standard Oil Co. of Indiana, repeated his instructive motion picture showing the mechanism of bearing lubrication by a colored oil-film in a glass bearing which was exhibited during the Summer Meeting of the Society.

Kingsbury's Experiments

In describing the experiments of Albert Kingsbury on the lubrication of journal bearings, Mr. Howarth related an incident that occurred while Mr. Kingsbury was a student at Cornell University. Machines for testing oils and bearing metals were then in vogue. Dr. Dudley, head of the Pennsylvania Railroad laboratory, had sent several bronze bearings to Cornell to be compared on Professor Thurston's oil-testing machine. Several students had tested them and invariably found the same relative superiority one to another. Professor Thurston then asked Mr. Kingsbury to compare them. Mr. Kingsbury, being an experienced and skillful mechanic, first fitted the bearings with equal care to the journal of the testing machine, then ran the tests, using the usual machine oil. One bearing-metal showed the same friction as all the others. Professor Thurston then suggested using lighter oil. Even with kerosene Mr. Kingsbury found no difference between the bronzes. Why? The bearings were fitted so well they did not touch the journal. The friction measured by the machine was only that of the oil, and it was the same with every bearing.

Mr. Kingsbury's notable experiments on air-lubricated journal bearings, said Mr. Howarth, were made in 1896. He measured the air-film thickness and the pressure all around the journal, also the friction. His tests proved by actual measurement the correctness of Osborne Reynolds' mathematical explanation of lubrication. To Mr. Kingsbury belongs the credit for obtaining the lowest reliable experimentally determined coefficient of friction, 0.00053. Later, he obtained a value of 0.00046 in some tests that have never been published. In 1901, Mr. Kingsbury measured the friction of oil-films and found that, at constant temperature and speed, the friction is inversely proportional to the film thickness down to the least thickness that could be measured, about 0.000025 in.

Rules for Bearing Lubrication

For the proper lubrication of bearings Mr. Howarth suggested the following general rules:

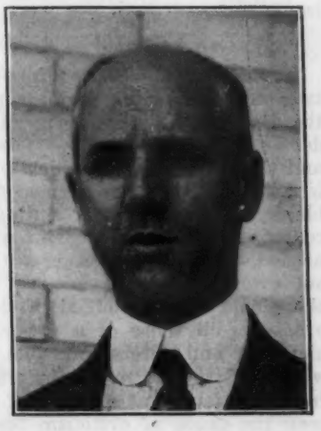
(1) When the bearing completely surrounds the journal, the bearing surface may be unbroken by grooves except one longitudinal groove along the surface about opposite the loaded side. Running clearance should also be provided, more for high than for low speed. For low speed, the single groove may be a small closed-end groove with drip lubrication, or it may be a large cooling groove with a forced oil-supply, for high speed

(2) Partial bearings are used by railroads and as lineshaft bearings in ships, with the bearing below the journal. The circumferential length of the bearing is usually 120 deg. or less. If so, and if not too heavily loaded, it can be bored with clearance, or it can be fitted carefully to the journal and be suitable for heavy as well as light loads. If a partial bearing covers more than 120 deg. of the journal, it should be bored with running clearance. Partial bearings require no grooves. The leading edge, where oil enters the film, should be slightly rounded

(3) Full bearings, with two opposite grooves, 90 deg. from the loaded side, are very common, when bearings are made in halves. No additional grooves should be used. Such bearings should be bored with running clearance, the amount depending on the speed and the load. High-speed bearings when heavily loaded may require some fitting even though provided with running clearance

WHEELS, BRAKES AND TIRES

Requirements of Motorcoaches and Trucks Investigated by Cleveland Section



J. E. Hale

Wheels, brakes and balloon tires for heavy-duty vehicles received a thorough discussion at the regular monthly meeting of the Cleveland Section on Nov. 16. Four papers were presented. The first was by J. E. Hale, of the Firestone Tire & Rubber Co., who outlined the experiences of his company in adapting low-pressure tires to motor coach service; Elmer A. Clark, of the Budd Wheel Corporation, Philadelphia, explained the problems confronting wheel engineers in manufacturing wheels for heavy-duty vehicles; J. Linforth, of the Goodyear Tire & Rubber Co., Akron, Ohio, reported some results of operating with low-pressure tires in inter-city service; and L. C. Huck, of Oak Park, Ill., presented a theoretical discussion of brake design for heavy vehicles. More than 200 members and guests were present, J. H. Jaschka acting as chairman.

Balloon Tires for Motorcoaches

Pneumatic tires for motorcoaches now require from 90 to 100 lb. per sq. in. pressure and when pumped up to that pressure are somewhat hard, said Mr. Hale. As a result, the vehicle suffers many jars, vibrations, rattles and jolts that make for uncomfortable riding. With such tires, riding-comfort must come from heavy bodies and springs; and

resort is made even to special seats to reduce the jar and make riding more comfortable.

Believing that a pressure of from 45 to 50 lb. per sq. in. is ample for motorcoaches, Mr. Hale described the work that had been done to develop a line of balloon tires for this service. Practically the same difficulties have been encountered, he said, as in developing balloon tires for passenger cars; but outside of harder steering, because of the larger area of contact with the road, no hindrance, he believed, would be met in operating the vehicles. Braking must be improved; but consumption of fuel should be no higher. One of the principal difficulties is produced by overloading. A "mileage expectancy" chart was used to show how mileage of tires decreases with overload.

Disc Wheels

Wheels and pneumatic tires for heavy-duty vehicles are so closely associated, said Mr. Clark, that it is virtually impossible to discuss them separately. Each imposes conditions upon the other. Development of pneumatic tires for heavy-duty vehicles has, until recently, suffered from this lack of coordination.

The use of small-size tires in dual formation has been impeded by the lack of a practicable wheel to complete the assembly. The dual wheel has received its best development abroad. What a tire requires for adequate service is some means of shifting the load, a protection against continually being called upon to do its maximum; in other words, more tires. This may be accomplished by six-wheel or eight-wheel vehicles or by axles carrying dual wheels. About 40,000 installations of the Budd-Michelin type of dual disc wheel are now operating in this Country.

The reason for the greater life of tires when used in dual formation depends largely on the greater stability to be found in four side walls than in two, as is the case with the giant single tire; the height of the side wall is reduced through the use of smaller tires, and the side roll is minimized or distributed over the four side walls. Other advantages to be gained through "dualing" are the possibility of using one size of tire for both front and rear, the suitability of one spare tire for all wheel positions, and the use of tires of smaller size and frequently of total less cost than that of a single tire of equivalent or even lower carrying-capacity.

Construction of Disc Wheels

Standard disc-wheel equipment, said Mr. Clark, consists of two parts: the hub, permanently mounted on the axle, and the disc and rim that form an integral construction and are demountable at the hub. The number of studs in the hub and the bolt circle on which the studs are set are standardized. The wheels are formed from a single disc of steel, the blank being tapered by rolling from a thick section at the center, where the load concentrates and where strength is needed, to a thinner section at the rim, where the load spreads out over a larger area. All wheels are formed in convex shape and are assembled in the rim under heavy hydraulic pressure, all those of a given rim size or bolt circle being identical and interchangeable. The same hubs will take wheels of the 20 or 24-in. size. Many advantages accrue from the fact that all wheels are convex but this has also been the cause of criticism because too much use has been made of the concave side. Center-pivot steering is easy with the convex type of disc wheel and advantage has been taken of the concave side for housing the brake-drums, a feature that enables the minimum tread and over-all width to be secured without reducing the spring centers. When used with 20-in. wheels, with their reduced brake-drum diameters coupled with an increased amount of braking, the tires suffer from excessive heat.

Using larger wheels tends to obviate this difficulty but imposes the additional burden of securing low floor and body heights. Injecting a current of air inside the drum may be sufficient to keep the temperature down to an allowable figure. The burden of relieving the heat has been thrown on the tire and the wheel, but changes in the brake-band material may assist. Asbestos brake-linings serve as insulators to hold the heat; metal-to-metal braking has been reported to relieve it.

Wheels Adaptable to Both Solid and Pneumatic Tires

Pneumatic tires are not adapted to all classes of service but it is possible to use wheels on which a change from solid to pneumatic tires can be made later, if such a change should be considered advisable. It is possible to mount a solid and a pneumatic-tired wheel in combination on the same hub. Motorcoaches thus equipped allow the vehicle to ride on the pneumatic tires when operating under light loads and on both the solid and the pneumatic tires when the load increases to a point at which the pneumatic would be overloaded. The quality of the riding is said to be better than that of solid tires alone and to be only slightly worse than that of exclusively pneumatic tires.

In Mr. Clark's opinion, the program for extending the use of pneumatic tires should be to obtain first a satisfactory wheel, then a versatile one. The wheel should be equally suitable for use in front, at the rear, as part of a dual assembly or singly and for either a single or a double-deck motorcoach or for a 5-ton truck.

Balloon Tires in Service

Mr. Linforth expressed the belief that the use of balloon tires on heavy-duty vehicles would come much more quickly than most motorcoach engineers appreciate. His experience has been that each balloon-tire installation has produced enthusiasm on the part of the operator because of the greatly improved cushioning effect, the increased minimum speed allowed and the additional selling appeal of the motorcoach, and that the patrons have commented favorably because of the greater riding-comfort and noticeable decrease in vibration and noise.

Among the observations made in watching the performance of approximately 300 balloon tires in service were the following: The mileage to be expected appears to be equal to that of high-pressure tires; as new wheels, and usually new hubs and brake-drums, are required in practically every case where dual rear wheels are used, the cost of changing over from high-pressure tires is high, consequently, the proper place for introducing the balloon tires is as original equipment on new motorcoaches; results show that punctures do not occur more frequently than with high-pressure tires; a decrease in the running-time is possible because of an increase of the minimum speed without increasing the maximum speed, owing to the fact that slowing-up is not necessary in passing over rough portions of the road; balloon tires add to the safety of the motorcoach because of their ability to hold the road on wet as well as dry surfaces better than do high-pressure tires; a large number of question cards returned by passengers express their satisfaction with the improved riding-quality.

Brake Design for Heavy Service

Brakes for heavy vehicles next received consideration in a paper presented by Mr. Huck. This problem becomes especially serious and difficult, he said, because the modern motorcoach not only combines weight and speed but, on account of frequent applications of the brakes, introduces the attendant problem of dissipating an increased amount of heat. In designing brakes a certain coefficient of friction must be assumed and, as this is likely to vary with the temperature, the problem of dissipating heat becomes important. As the diameter of the brake-drum cannot be increased in proportion to the increase of weight and as the weight of a heavily loaded motorcoach is approximately 20,000 lb. as compared with less than 5000 lb. for that of a passenger car, about four times the braking effort is required; consequently, the operator must exert four times the pedal pressure. As the operator's muscular development is limited, some outside force, such as compressed air, intake-manifold vacuum or the inertia of the moving vehicle, must be utilized to supplement it. In the author's discussion, only the last named force, termed "self-actuation," is considered.

Besides having greater ease of operation, said Mr. Huck, brakes that are as sensitive as possible without being "grabby" are desirable, as they allow the reduction of the mechanical advantage in the brake-operating linkage. This, in turn, results in less frequent adjustments for wear, elimination of the necessity for an uncomfortably great pedal-throw, and, in the case of internal brakes, makes it possible to "follow-up" the expansion of the brake-drum due to heating.

Further limiting his discussion to that of the actuation of a rigid-shoe type of internal brake, Mr. Huck submitted a mathematical analysis of the forces entering into brake design and the determination of the values of the actuation factor, actuation constant, anchor-pin ratio, the limits of the safe arc of contact without the possibility of grabbing, and the relative actuation, braking effort and life of journaled and floating cam brakes.

Blow-Outs

Replying to a question in the discussion that followed, Mr. Hale stated that blow-outs of balloon tires were not more frequent nor more serious than those of high-pressure tires, and that he had heard of only one case of shimmying.

Regarding the relative merits of single and dual tires, I. R. Renner, of the B. F. Goodrich Co., while admitting that, with single tires, two sizes of spare are necessary, that immediate change is obligatory in case of puncture or failure of the tire and that greater loss is incurred if the tire is run when deflated, maintained that single tires are all "working," less time is required for inflation and the over-all width of the vehicle is reduced; also, that equalizing the pressure in dual tires is difficult and that, if one fails, the other is not capable of withstanding the additional pressure. But the question, he said, was not which tire appeals to the operator or the manufacturer, but how it fits best into his program.

The heating problem caused animated discussion, the consensus of the opinions of several speakers being that the heat should be removed by inducing a greater circulation of air.

H. D. Hukill called attention to the fact that experiments with power brakes made several years ago had demonstrated that uniform braking results could be obtained with metal-to-metal brakes, that with them the cooling is better than with fabric-lined brakes and that, if the heat can be removed, metal-to-metal brakes can be used on mountain grades on which fabric linings would burn out.

AUTOMOBILE TESTS AND EXHAUST EFFECT

New England Section and New Haven Mechanical Engineers Hold Joint Meeting

Rear-Wheel Tests of 100 Automobiles, by Prof. E. H. Lockwood; Toxic Effects of Motor-Vehicle Exhaust, by L. E. Crooks; and Truck Transmission Efficiency Experiments, by L. M. Porter, were the titles of three papers that featured a joint meeting of the New Haven Section of the American Society of Mechanical Engineers and the New England Section of this Society, at Mason Laboratory, Yale University, New Haven, Conn., on Nov. 19.

During the afternoon preceding the meeting a demonstration of rail-cars was given by the New York, New Haven & Hartford Railroad under the direction of W. L. Bean, assistant mechanical manager, and his assistants, H. P. Haas and D. L. Bacon. Two types of car were displayed, illustrative of those now in use on branch lines. The runs were made from New Haven to Devon Junction, near Bridgeport.

Professor Lockwood's paper comprised reports on tests of automobiles that have been carried on at the Mason Laboratory since 1916, the term automobile being used in its widest sense and including motorcycles and trucks as well as passenger cars.

The paper by Mr. Crooks covered the problem arising from the exhaust from motor vehicles, the subject being discussed from both the sanitary and engineering viewpoints in a humorous as well as instructive manner.

Mr. Porter's contribution was of the nature of a progress report and described the apparatus and methods being used to measure the friction of truck transmissions. The essential feature of the apparatus was said to be a cradle dynamometer that is substituted for the gasoline engine, while a rear-wheel dynamometer registers the torque at the rear tires, the difference between the input and output torques giving a direct measure of the friction. M. R. Wolfard, chairman of the Section, presided.

MECHANISM OF LUBRICATION

D. P. Barnard Exhibits Motion Picture Showing Oil Flow Before Dayton Section

The visualization of lubrication entertained the members of the Dayton Section and their guests at the regular monthly meeting on Nov. 25. D. P. Barnard, 4th, of the Standard Oil Co. of Indiana, was the speaker of the evening and enlivened the meeting by repeating his interesting and instructive motion picture showing the mechanism of lubrication by a colored oil-film that could be seen through a glass bearing. This picture was the same as that shown to members at the Summer Meeting of the Society.

Mr. Barnard gave a preliminary explanation of the lubrication process by stating that sliding surfaces, when heavily loaded and working at low speed, are lubricated by the property of the lubricant called "oiliness"; elsewhere, the lubrication is effected by the viscosity of the fluid film. This film is formed by the action of the lubricant in adhering to the journal while it is in motion and in being dragged along with it between the rubbing surfaces. Conditions, therefore, must be such that an adequate supply of lubricant will be provided and an opportunity given for it to be trapped between the rubbing surfaces and actually wedge them apart. Hence, a certain amount of clearance is requisite. The next essential is a flow of oil; that is, the oil must flow from some point where the journal can pick it up, carry it through the bearing and discharge it again. Care must be taken that the oil cannot escape before doing its work, consequently, the loaded side of the bearing should contain no oil grooves. These should be on the unloaded side, where the oil can gain an easy entrance. Placing oil grooves on the loaded side, instead of putting oil where it is needed, tends merely to decrease the effective area of the surface that can form a supporting film.

In showing the pictures, Mr. Barnard explained that, for sake of simplicity, the initial study had been made of a bearing without grooves and that to visualize the action of the oil through the glass bearing a mixture of glycerine and dye of approximately the same viscosity as the oil had been mixed with it.

URBAN TRANSPORTATION

THE extent to which the public is using local transportation supplied by companies operating electric railways is phenomenal. Last year, it totaled approximately 16,000,000,000 persons. This represented three-fourths of all travel within cities. The vehicles bearing this traffic comprise but one-fourth of the total number of vehicles used on the streets. Even though every person were financially able to use some other vehicle, it is clear that enough street-space could not be provided for the vehicles.

The cities of our country have grown to their preeminent greatness by reason of the excellence of the public transportation that has been provided. No city can expand in area or in industrial importance unless this vital agent is prepared to take the lead in such expansion.

Almost 50,000,000 passengers now are riding on the electric cars of the United States every day. If even one-half of our city population attempted to travel only by motor car, the streets would be absolutely impassable.

The Place of the Motorcoach

The motorcoach has a very definite place in local transportation but it is not destined to take the place of all electric cars or any considerable percentage of them in urban travel. In any city the mass of the people travel within limited periods of time. In fact, fully one-half of all local riding is done in most cities during about 4 hr. of the day. For this reason vehicular space is at a great premium during that time, and the vehicle that will carry the largest number of persons and make the best time is the one that will endure. The only vehicle created up to the present time that will do this satisfactorily is the electric car.

In supplemental service the motorcoach is performing a very good work. More than 4000 motorcoaches now are being operated by electric-railway companies and many more of them will be operated in the future. It is a significant fact that although we have been hearing for a number of years that the motorbus, as it was formerly called, was about to supplant the electric car, no city in the United States of over 50,000 population now is dependent solely on vehicles of this character for its local transportation service.

The motorcoach has had every opportunity in London to supplant the electric car, if it were capable of so doing. It has been relieved of practically all tax obligations, but until recently was not required to maintain schedules, being permitted to roam about wherever it pleased to pick up passengers. In fact, in a very large part of downtown London, electric cars are not permitted to operate, and in this section motorcoaches have had full sway. Despite these advantages, the best the motorcoach was able to do in London, up to the time that it so congested the streets that further additional movements were impossible, was to carry something less than 40 per cent of the total traffic. Electric cars were found to be absolutely essential to local-traffic movements. Furthermore, so great has become the congestion from the motorcoaches doing a 40-per cent service, that approximately one-fourth of these vehicles now are about to be removed by the London Traffic Committee.

Use Vehicles Best Fitted to Give Service

The private automobile has given the people such a convenient means of travel that the so-called "riding habit" of the cities has changed. In this transition period it is necessary to make a scientific survey of each community to determine just what service is really required. The service must be built up by the use of such vehicles as will give the best results.

The progressive electric railways, and those which are approaching financial success most rapidly, are the ones that no longer consider themselves merely railway corporations, but the transportation agents of their communities prepared to use to the fullest extent both rail-cars and motorcoaches for the convenience of the public.

The art of urban transportation has been a gradual, slow development. The motor vehicle, as a valuable medium of such transportation, has taken 10 years to reach its present form, and marked improvements will be required before its actual place in the transportation fabric can be determined. The motorcoach or stage is a fixture in practically every community for the complete development of the requirements of the people for travel. Its use must, however, be such that it will fit into the public requirements for a completely coordinated system of transportation serving all portions of the city. Primarily, it must be under the same regulation as the other medium of public transportation and its use must fill in the apparent need for service.—From an address, at Babson Park, of Managing Director Storrs, of the American Railway Association.

SPECIAL CAR REQUIREMENTS OF THE ORIENT[1]

IN 1921 I had the pleasure of visiting 15 countries in the Far East in the interests of the motor car business and found that in the Orient they also have a few engineering problems. In Japan, because there are no sidewalks, pedestrians as well as motor cars must use the streets, and, as there is a great deal of rain, it is necessary to devise a splash apron or fender to be attached to the wheel hub to hang down beside the wheel so that muddy water will not be splashed on the pedestrians in the narrow streets. The Japanese driver who drove me around Tokio and to the Japanese motor truck factories, said that there were more than 500 different types and fittings of these wheel aprons.

In the Philippines and in Singapore the average mud fender on the American automobile lasts about 30 days. There is some chemical in the water or the ground that eats the metal. The fenders on even our highest-priced cars had to be replaced with fenders of a different material in from 30 to 60 days.

In Siam it was impossible to sell a closed automobile because the only time when automobiles were used in that country was in the evening after the sun had gone down. They were used only for cooling off after the heat of the day, by the American and European residents, who always had the tops down.

The use of any kind of a signaling device except a bulb horn was not permitted in most of the Oriental countries at that time. Every American car with an electric horn had to have it removed immediately. It was also against the law to use an exhaust whistle.

The customary American top material was not suitable for those countries and the tops had to be replaced with khaki tops that would withstand the sun and torrid rains.

Those are extreme examples that indicate the possibilities of development of motor vehicles that will more nearly meet the cross-section of demand in this part of the world.

[1]Abstract of remarks at the meeting of the Southern California Section, May 22, 1925, made by Don Smith. Mr. Smith is vice-president of the Los Angeles Automobile Dealers Association, Los Angeles.

STANDARDIZATION ACTIVITIES

The work of the Divisions and Subdivisions of the S. A. E. Standards Committee and other standards activities are reviewed herein

MOTORCOACH BATTERIES SIMPLIFIED

Seven Sizes Recommended by Storage-Battery Division for Future Practice

The present S.A.E. Standard for Storage-Batteries covers passenger-car and motor-truck batteries, but, owing to the special requirements of motorcoach service, is not satisfactory for the last-named service. The need for standard motorcoach sizes was, accordingly, considered by the Storage-Battery Division.

Information on current practice was obtained and a special Division meeting held on Nov. 12, at which the data were reviewed and seven sizes of battery selected as meeting satisfactorily the present requirements of the motorcoach industry.

The existence of motorcoach storage-battery standards will make it possible for motorcoach engineers to design battery compartments of such size that, in case it is impossible to obtain batteries from the original source of supply, other makes of battery can be used without rebuilding the compartments or using undersized batteries.

The battery dimensions recommended are over-all dimensions. Although the capacities that have been specified for passenger-car and motor-truck batteries are based on the 20-hr. and 20-min. ratings, it is proposed to rate motorcoach batteries on the basis of the minimum current in amperes for 20 min. and the minimum capacity in ampere-hours at an 8-hr. rate. The 8-hr. period was selected on the assumption that an emergency requiring the entire lighting-load for more than 8 hr. would seldom arise and that the resulting current-rate, if based on a 3 or 5-hr. period, would be too high. The dimensions of battery sizes proposed are as given in the accompanying table.

PROPOSED MOTORCOACH STORAGE-BATTERY DIMENSIONS

Battery No.	No. of Cells	Maximum Over-All Dimensions, In. Length	Width	Height
21	3	17	7⅝	10¾
22	3	19⅛	7⅝	10¾
23	3	25⅞	7⅝	10¾
24	6	26¾	7⅝	10¾
25	6	20⅞	9⅝	10¾
26	6	27¼	7⅝	10¾
27	6	30⅞	7⅝	10¾

The proposed sizes will be extended to include the capacities based on the 8-hr. and 20-min. ratings and the complete recommendation submitted for adoption at S.A.E. Recommended Practice at the January Meeting of the Standards Committee.

The reduction to practice of the proposed motorcoach battery standards will be impossible without the active cooperation of the motorcoach builders. If they are not in favor of restricting their purchases to the sizes standardized, battery manufacturers can be found who will make non-standard sizes. On the other hand, motorcoach builders not entirely "sold" on the importance of standardizing motorcoach batteries can be influenced to abide by the standard sizes adopted, provided the battery manufacturers appreciate the importance of limiting production to only standard sizes and will explain matters clearly to such prospective purchasers.

Those present at the Storage-Battery Division meeting were W. E. Holland, of the Philadelphia Storage Battery Co., chairman; A. K. Brumbaugh, of the Autocar Co.; Bruce Ford, of the Electric Storage Battery Co.; L. E. Lighton, of the Electric Storage Battery Co.; E. L. Longaker, of the Electric Storage Battery Co.; Irvine M. Noble, of the Consolidated Battery Co.; J. L. Rupp, of the Westinghouse Union Battery Co.; Dr. G. W. Vinal, of the Bureau of Standards; and C. E. Heywood, of the Society Standards Department.

TO REVIEW ELECTRICAL STANDARDS

Motorcoach Practice Requires Special Generator and Starting-Motor Mountings

It was brought out at the October meeting of the Electrical Equipment Division that the present S.A.E. Standards for Generator and Starting-Motor Mountings are not suitable for motorcoach service and that special mountings designed for loads encountered in motorcoach practice should be developed. It was also thought that the present standard mountings should be carefully reviewed as changes have been taking place in passenger-car practice that will necessitate changes in the present specifications.

As it was thought advisable to appoint a special Subdivision to make this review and to develop any new specifications found necessary, the following Subdivision was appointed:

T. L. Lee, *Chairman*	North East Electric Co.
W. B. Churcher	White Motor Co.
M. P. Ferguson	Eclipse Machine Co.
L. P. Kalb	Continental Motors Corporation
C. H. Kindl	Remy Electric Co.
E. T. Larkin	Sterling Engine Co.
B. M. Leece	Leece-Neville Co.
W. P. Loudon	Dayton Engineering Laboratory Co.
G. J. Rackham	Yellow Coach Mfg. Co.
M. E. Toepel	International Motor Co.

FURTHER TESTS TO BE MADE

Result of First Series of Tests on Black Baking-Enamel Inconclusive

At a meeting of the Subdivision on Black Baking-Enamel held in Detroit on Oct. 22, the results of the cooperative tests that had been made in the last year on black baking-enamel were reviewed and it was decided to make a new series of tests that, it is hoped, will prove that laboratory tests can be specified that will indicate how enamel will endure in actual service.

The cooperative tests in the last year were made by 13 laboratories connected with the enamel and car manufacturers represented on the Subdivision, the tests having been started in October, 1924, as a result of a meeting held at that time. The material tested was obtained by the Standards Department from the enamel manufacturers and sent to the testing laboratories in quart cans under identification symbols known only to the Standards Department. The laboratory tests on these samples were checked by exposure tests made during the year, all tests having been agreed upon by the Subdivision at the October, 1924, meeting.

At a meeting of the Subdivision members on Oct. 22, 1925, it was impossible to base any definite conclusions on the results of the exposure tests, the results for the various grades of enamel varying over a wide range. It was, consequently, decided to obtain further samples of enamel for the purpose of making another series of tests on three quali-

ties designated as high, medium and low-grade. To obtain definite agreement as to the result of the exposure tests, the test panels are to be sent to one member of the Subdivision for exposing, meetings of the Subdivision to be held at his office at the end of 1, 3 and 5 months and 1 year to examine the condition of the test panels.

SPARK-PLUG STANDARD REVISED

Definite Skirt Lengths of 5/8, 13/16 and 1 In. Specified in Proposed Change

At the October meeting of the Engine Division, the following spark-plug dimensions were recommended as a revision of the present S.A.E. Standard for Spark-Plugs, printed on p. A10 of the S.A.E. HANDBOOK:

Hexagon.—All spark-plug shells shall have a hexagon of 15/16 or 1⅛ in. across the flats

Skirt Lengths.—The distance from the gasket seat of the spark-plug to the end of the spark-plug shell, commonly known as the "skirt length," shall be ⅝, 13/16 or 1 in.; and the length of the thread for the ⅝ and 13/16-in. skirt-lengths shall be ⅜ in. and for the 1-in. skirt-length, 23/32 in.

Terminal Threads.—The terminal threads shall be No. 8—32 or 0.183 in.—32

Firing Points.—The maximum projection of the firing-points below the shell shall be 3/16 in.

Clearance.—The minimum distance from the spark-plug seat to the nearest object over the spark-plug shall be 2¾ in.

Metric Spark-Plugs.—The title for the present standard printed on p. A11 for "Aeronautic Spark-Plugs" shall be changed to "Metric-Type Spark-Plugs"

The Engine Division action in connection with the above dimensions was taken only after a careful analysis of current practice, both by the Division and by the Spark-Plug Subdivision under the chairmanship of A. A. Bull. A summary of current practice, indicating the number of companies using the dimensions adopted as standard, is given in Table 1.

TABLE 1—NUMBER AND PERCENTAGE OF AUTOMOBILE BUILDERS USING VARIOUS SPARK-PLUG DIMENSIONS

Spark-Plug Shell Threads[1]

Thread	Number	Percentage
⅞ in.—18	176 (28)	95 (85)
Metric	6 (2)	3 (6)
Pipe (½ in.)	5 (3)	2 (9)

Hexagon Dimensions

⅞ in.—18 Spark-Plug			Metric-Type Spark-Plug	
Hexagon	No.	Percentage	Hexagon	No.
1⅛	132 (19)	73 (68)	1 in.	6 (2)
15/16	26 (5)	14 (18)	½-in. Pipe Spark-Plug	
⅞	24 (4)	13 (14)	15/16 in.	5 (3)

Lengths from Shoulder to End of Shell for ⅞ In.—18 Spark-Plug

Length, In.	Number	Percentage
19/32	3 (1)	1.6 (3)
⅝	137 (14)	74.6 (50)
11/16	1 (0)	0.5 (0)
¾	1 (0)	0.5 (0)
13/16	21 (5)	11.4 (18)
⅞	12 (6)	6.5 (22)
15/16	4 (2)	2.2 (7)
1⅛	4 (0)	2.2 (0)
1¼	1 (0)	0.5 (0)

Terminal Thread

Thread	Number	Percentage
0.183 in.—32	110 (19)	56.2 (57)
No. 8—32	83 (14)	42.3 (43)
No. 10—32	1 (0)	0.5 (0)
No. 7—36	1 (0)	0.5 (0)
5/32 in.—32	1 (0)	0.5 (0)

Projection of Points

Distance, In.	Number	Percentage
3/16	111 (19)	56.7 (57)
5/32	84 (14)	42.8 (43)
⅛	1 (0)	0.5 (0)

[1] Figures in parentheses indicate the number or percentage of the 33 cars having the largest production.

The reason for specifying a minimum clearance of 2¾ in. over the spark-plug seat is that certain car builders have located metal covers and other metallic parts too near the spark-plug terminals, this resulting in short-circuiting under certain operating-conditions. It is believed that this matter should be given proper attention by designing engineers, as certain definite spark-plug over-all lengths must not be exceeded if the spark-plugs are to operate properly. This situation was covered in an article appearing in the April, 1925, issue of THE JOURNAL, on p. 411.

The present S.A.E. Standard does not specify definite skirt-lengths, but a ⅝-in. minimum dimension. The varieties of spark-plug that are necessary to service existing automobiles is being simplified by the spark-plug manufacturers to decrease the capital tied up in service stocks and it is consequently believed desirable to extend the present standard to specify definite skirt-lengths. With the three skirt-lengths proposed, the specifications cover seven spark-plug sizes, as is shown in Table 2.

TABLE 2—PROPOSED S.A.E. STANDARD SPARK-PLUG SIZES

Thread	Hexagon	Skirt Length
⅞ in.—18	15/16	⅝
⅞ in.—18	15/16	13/16
⅞ in.—18	15/16	1
⅞ in.—18	1⅛	⅝
⅞ in.—18	1⅛	13/16
⅞ in.—18	1⅛	1
18 mm.—1½ mm.	1	9/16

Although the 1-in. skirt-length is not used to material extent in present production, it is specified because of the tendency in engine design toward smaller cylinders, making longer spark-plugs desirable to allow more room for the water-jacket.

Since the original survey of current practice was made, it has been stated that several car builders are considering adopting the 15/16-in. in place of the ⅞-in. hexagon, and the Division hopes that eventually the standard, revised as proposed, will be adopted by every builder of automotive vehicles.

LAMP GLASS DIAMETERS UNCHANGED

Present Standard for Notching Revised To Specify but One Notch

To determine the effectiveness of the present S.A.E. Standard for Head-Lamp Glasses, p. B3 of the S.A.E. HANDBOOK, a resurvey of general practice was made which indicated that the standard 8-5/32, 8½, 9 and 9½-in. outside diameters were used by only 32 of 72 passenger-car companies, or by about only 40 per cent. The notching dimensions specified in the standard were used by certain manufacturers in some details, but by no manufacturer in all details. It was felt that the standard had not been adopted more generally because of the individual requirements of the car builders, but information obtained in this connection showed that of 30 companies, 4 made it a policy to specify the glass dimensions, whereas 26 left this matter entirely to the lamp manufacturers.

At a meeting of the Lighting Division in October it was stated that, although the information as to the extent of the use of this standard did not seem to be particularly encouraging, considerable good had really been accomplished, especially in view of the fact that automobile head-lamps are getting to be more in the class of specialty products. It was recommended, however, that a single notch at the bottom of the glass should be specified instead of four notches, located on

the horizontal and vertical center-lines and that head-lamps should be so constructed that the glass cannot be improperly installed.

PATCHING OF LEATHER APPROVED

The following clause has been approved by the Passenger-Car Body Division for inclusion in the specifications for Upholstery Leather now printed on p. L7 of the S.A.E. HANDBOOK:

> Not more than 15 per cent of the hides supplied may have up to five patches. The patches shall be equal to the rest of the hide in strength and flexibility, shall be invisible from the finished side and shall be waterproof. Weak or open veins and knife-cuts shall be reinforced and classed as patches.

At the 1925 Annual Meeting, the patching of grub-holes and other defects in upholstery leather was recommended by K. L. Herrmann, of the Studebaker Corporation of America, in a paper on automobile upholstery. It was stated at that time that patching methods had been developed which resulted in patches that were as strong and as flexible as the hide and that could not be detected from the finished side. The use of patched hides was not permitted by the leather specifications adopted at that meeting, however, as manufacturers were not equipped to patch leather in production, the patches being of temporary nature intended to prevent the coating from penetrating the hide. Since that time information has been obtained showing that leather is now being patched satisfactorily, a pyroxylin cement being used.

PISTON-RING OVERSIZES ADOPTED

Engine Division Approves Report Submitted by A. W. Reader

The report on Piston and Piston-Ring Oversizes prepared by the subdivision, of which A. W. Reader, of the General Motors Corporation, is chairman, the other members being R. J. Broege, of the Buda Co., and A. F. Milbrath, of Wisconsin Motor Mfg. Co., was adopted at the October meeting of the Engine Division. This report, which was drafted as a result of the conference held in December, 1924, under the auspices of the Division of Simplified Practice of the Department of Commerce, as reported on p. 319 of the October issue of THE JOURNAL, follows:

> Standard oversize pistons for passenger-car, motorboat and airplane internal-combustion engines shall be 0.003, 0.005, 0.010, 0.015 and 0.030 in. The standard oversizes for tractor, truck and industrial internal-combustion engines shall be 0.010, 0.020, 0.030 and 0.040 in. Larger oversizes, when necessary, shall be held to multiples of 0.010 in.
>
> Piston-rings shall be held to the same oversizes, omitting the 0.003-in. oversize, as are specified for pistons.

At the Engine Division meeting, comments submitted by the passenger-car and truck builders with reference to the proposed oversizes were reviewed. Although the report met with general approval, the following comments are of interest.

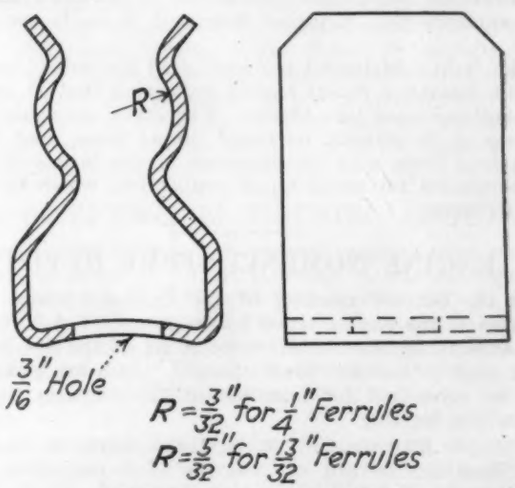
> We see no good reason for the inclusion of the 0.010-in. oversize piston, particularly for truck work as very little advantage, if any, is gained from a power standpoint by fitting new pistons of this size in a worn bore. Cylinder bores are usually worn tapered or out-of-round to such an extent that it would be difficult to fit a piston of this size in a bore with only a moderate amount of wear.
>
> As for the 0.020-in. oversize, a cylinder worn sufficiently to take a 0.020-in. piston would in our opinion require regrinding, and cylinders that require regrinding do not as a rule clean up with less than 0.030-in. increase in diameter.
>
> We have, therefore, established our practice on a basis of these two dimensions, using standard pistons for all normal replacements where regrinding is not required.
>
> We have found, from past experience, that the regrinding sizes for cylinders should be spaced 0.015 in. apart to conserve the life of the cylinder-block and also to clean up the large majority of cylinders that require regrinding and refitting with new pistons and rings. We carry the 0.005-in. oversize piston for lapping in blocks that have one or two cylinders worn a trifle oversize or out-of-round, but not seriously enough to warrant regrinding all the cylinders.
>
> We do not approve the carrying of 0.003, 0.010 and 0.020-in. oversize pistons in addition to the regular 0.005, 0.015, 0.030 and 0.045-in. oversizes as this increases the dealer's investment considerably without any compensating result. We recommend the fourth regrinding size on our engines as this increases the life of the block approximately 25 per cent, although we realize that the manufacturer who may have a thinner cylinder-wall to begin with or has less accurate foundry work might not find this practice feasible.

FUSE-CLIP RADII SPECIFIED

Electrical Equipment Division Recommends Radii To Obtain Four-Point Contact

The present S.A.E. Standard for Fuses and Fuse-Clips, p. B32 of the S.A.E. HANDBOOK, specifies that clips shall be made so that fuses cannot slip out accidentally and shall be fastened to a base such that they cannot turn.

At the October meeting of the Electrical Equipment Division it was thought that the standard should specify a radius for that part of the clip which holds the fuse and that this radius should be slightly smaller than the radius of the ferrule on the fuse so as to obtain the four-point contact. It was, consequently, recommended that the present standard be revised to specify a 3/32-in. radius for ¼-in. ferrules, a 5/32-in. radius for 13/32-in. ferrules and a 3/16-in. screw-hole in the bottom of the fuse-clip, as shown in the accompanying drawing.



PROPOSED STANDARD FUSE-CLIPS

The Division recommended also that the voltage specified for lighting circuits be increased from 25 to 40, because of the increase in the use of 32-volt systems on motorcoaches.

TRANSMISSION BRAKE-DRUMS CONSIDERED

At the October meeting of the Transmission Division it was suggested that specifications should be drawn up for the transmission type of brake-drum in view of the extensive

use of this type of brake on passenger cars, as a result of the introduction of the four-wheel brakes, and on motor-coaches and other heavy vehicles. The Standards Department is to obtain information on current transmission brake-drum practice as a basis for future Division deliberation.

"DEPRESSED BEAM" STANDARD NEEDED

Lighting Division To Prepare Specifications for New Type of Illumination

At the October meeting of the Lighting Division, the need for a definite specification covering the characteristics of head-lamp illumination when the beam is depressed or tilted was emphasized. C. A. Michel, chairman of the Division, in accordance with the Division recommendation that specifications should be prepared, appointed J. H. Hunt, of the General Motors Corporation Research Laboratories, chairman of the Subdivision to handle this problem, the other members being R. N. Falge, of the National Lamp Works of the General Electric Co.; C. E. Godley, of the Edmunds & Jones Corporation; C. A. Michel, of the Guide Motor Lamp Mfg. Co.; L. C. Porter, of the Edison Lamp Works, and Dr. C. H. Sharp, of the Electrical Testing Laboratories.

The Subdivision was asked also to consider spot-lamp illumination, it being felt that, if found feasible, a definite lighting specification should be drafted.

BALL-HANDLE THREADS ADOPTED

3/8-In.—24 Thread Proposed for Passenger Cars and 1/2-In.—20 for Trucks

The result of the survey of current practice for control-lever ball-handle insert threads reported on p. 414 of the November issue of THE JOURNAL was reviewed at the October meeting of the Transmission Division. It was felt that the present Standard on p. J2 of the S.A.E. HANDBOOK specifies a large number of unnecessary dimensions, as the purpose of the specification is only to obtain interchangeability of control-levers and ball-handles. It was consequently recommended that the present standard be restricted to only the 1/2-in.—20 thread, this thread being specified for motor-truck applications, and a 3/8-in.—24 thread specified for passenger-car applications. A thread length of 5/8 in. is specified for both.

The 3/8-in.—24 thread is widely used for control-lever ball-handle inserts, a recent survey indicating that 11 out of 36 car builders used this thread. The other companies used a variety of 10 threads, no single thread being used by more than four firms with the exception of the 1/2-in.—20 thread, recommended for motor-truck application, which is used by five builders.

ENGINE NOMENCLATURE REVISED

At the October meeting of the Engine Division, certain changes in the engine terms in the present S.A.E. Standard for Automobile Nomenclature on p. K1 of the S.A.E. HANDBOOK were proposed. These changes, which are given below, will be submitted for adoption at the January Standards Committee Meeting.

Page K3, Group 2.—Omit the sentence reading "'Bushing' instead of 'bearing' for removable and renewable lining used in plain bearing"

In "Crankshaft front-bearing bushing" omit the word "bushing"

Following "Crankshaft front-bearing cap" insert "Crankshaft bearing-cap stud (screw or bolt)"

In "Crankshaft rear-bearing bushing" omit the word "bushing"

In "Crankshaft center-bearing bushing" omit the word "bushing"

In "Crankshaft second-bearing bushing" omit the word "bushing"

Page K3, Group 3.—Change "Flywheel studs" to read "Flywheel bolts"

Page K3, Group 4.—After "Starting-crank shaft" insert "Starting-crank shaft spring"

Page K5a, Group 1.—Substitute "Fan bracket" for "Stationary fan support" and "Fan spindle" for "Adjustable fan-support"

After "Fan hub" insert "Fan-hub bushing (or bearing)"

Page K6, Group 3.—At the end of this group add "Water-pump shaft bushing (or bearing)" and "Water-pump packing"

STANDARDS COMMITTEE ACTIVITY

Since January, 1923, a monthly bulletin has been issued to the members of the Standards Committee, the Council and other interested members, covering the Standards Committee activity and giving the status of each standardization project before the Society. An important part of this bulletin is a summary of the number of subjects on which actual progress has been made, the number of subjects renewed or assigned by the Council, the number discontinued, the total number under consideration, the number of actual recommendations adopted, and the number of Division and Subdivision meetings. A recapitulation of these items, giving the 1923 and 1924 monthly averages, the 1925 monthly average to date and the activity for the month of October appears in the accompanying table.

SUMMARY OF STANDARDS COMMITTEE DIVISION ACTIVITY

	August, 1925	Monthly Average 1925	1924	1923
Subjects Active during Month	51	28	20	21
Subjects Assigned or Renewed	10	13	5.6	4.8
Subjects Discontinued	3	5	2.7	3.8
Subjects in Progress	105	66	73	83
Recommendations Submitted	9	4	4.1	4.6
Meetings	9	3	2.8	4.1

Copies of the Standards Bulletin will be sent to any members who wish to be informed on more of the details of the standards work than are given in the Standardization Activities section of THE JOURNAL.

TANK MOTOR-TRUCK REGULATIONS

Truck Division Reviews Rules Proposed by National Fire Protection Association

At a meeting of the Truck Division in Detroit on Sept. 24 regulations proposed by the Conference Committee of the National Fire Protection Association covering gasoline-tank trucks were reviewed by the Truck Division and modifications suggested. The regulations, as modified by the Division, follow:

SAFEGUARDS FOR INHERENT HAZARDS ON TANK TRUCKS

SEC. 8—TANK-TRUCK FUEL SYSTEM

(*a*) *Fuel-Tank.*—The main fuel-tank shall not be placed over or adjacent to the engine. It shall be constructed and mounted in such a manner as to present no unusual fire hazards. The tank shall be arranged to vent during the filling operation and shall permit draining without its removal from the mounting.

(*b*) *Fuel-Feed System.*—The fuel-feed system shall be constructed and located so as to minimize the inherent fire hazard. When necessary, a pressure-release device shall be provided.

(*c*) *Fuel-Line.*—The fuel-line shall be of proper material, having all connections made with suitable fittings, shall be equipped with a shut-off valve and shall be supported to prevent chafing and vibration.

(*d*) *Carbureter.*—The carbureter shall be so constructed and installed that the inherent fire-hazards involved by its use shall be reduced to the minimum.

Direct drainage of overflow gasoline shall be provided for.

(*e*) *Construction and Installation.*—All parts of the fuel-feed system shall be constructed and installed in a workmanlike manner.

SEC. 9—ELECTRICAL EQUIPMENT

(*a*) *High and Low-Tension Wiring.*—The high and low-tension wiring shall be provided with suitable insulation and shall have sufficient current-carrying capacity and mechanical strength.

(*b*) *Splices.*—Splices in wiring, if necessary, shall be made, protected and supported in a workmanlike manner.

(*c*) *Connections.*—Wiring connections shall be made with suitable fittings or terminals.

(*d*) *Protection of Wiring.*—The wiring shall be supported and protected from mechanical injury, chafing and exposure to or contact with oil, grease or gasoline and shall be so located as to avoid damage to insulation from heat.

(*e*) *Fuses.*—Suitable fuses or other automatic overload protective devices shall be installed in all low-tension circuits, except the ignition and starting-motor circuits. When a generator is used, an ammeter should be installed.

(*f*) *Construction and Installation.*—All electrical units shall be constructed and installed in a workmanlike manner.

(*g*) Electric lighting only shall be used.

(*h*) The preferred location of the tail-lamp is at the extreme rear end of the tank at the upper left-hand corner.

(*i*) It is recommended that the voltage of starting and lighting systems be 6 or 12 volts.

SEC. 10—EXHAUST SYSTEM

(*a*) The exhaust system, including muffler and exhaust line shall have ample clearance from the fuel system and combustible materials and shall not be exposed to accumulation of grease, oil or gasoline.

(*b*) The exhaust system, including all units, shall be constructed and installed in a workmanlike manner. A muffler cut-out shall not be incorporated.

Although it rests with the National Fire Protection Association to prove the necessity for the regulations proposed, the Committee asked the Society to cooperate in this work as it was felt that the recommendations relating to truck construction should come from the truck builders. The project was, therefore, assigned to the Truck Division as an advisory matter not related to the regular Standards Committee work of the Society, the recommendation of the Truck Division to be referred to the National Fire Protection Association, not as a recommendation of the Society, but merely as the opinion of members of the Truck Division.

Those present at the Division meeting were N. G. Anderson, of the International Harvester Co.; W. J. Baumgartner, of the Garford Motor Truck Co.; A. K. Brumbaugh, of the Autocar Co.; Charles Froesch, of the International Motor Co.; E. W. Harris, of the White Motor Co.; V. Link, of the Studebaker Corporation of America; S. W. Mills, of the Pierce-Arrow Motor Car Co.; D. F. Myers, of the Service Motors, Inc.; J. F. Winchester, of the Standard Oil Co. of New Jersey; and Standards Department Manager R. S. Burnett.

COOPERATIVE TESTS TO BE MADE

Following a meeting in New York on Oct. 22, the manufacturers of upholstery leather substitutes decided upon a series of cooperative tests to determine the value of different methods of testing leather substitutes. The leather substitutes to be tested will consist of samples backed with a sateen, a broken twill and a double-texture material, each to be furnished by manufacturers without usual identifying marks. The samples will be identified by a code known only to the Standards Department, test-specimens cut from each being sent to the members of the Subdivision cooperating in the tests.

The members of the Subdivision present at the October meeting were E. H. Nollau, of the DuPont Fabrikoid Co., chairman; R. C. Bowker, of the Bureau of Standards; K. L. Childs, of the Fabric Body Corporation; E. K. Files, of the Duratex Co.; G. Gurska, of the Zapon Leather Cloth Co.; and C. E. Heywood, of the Society Standards Department.

ELECTRICAL NOMENCLATURE REVISED

Certain terms in the present electrical-equipment nomenclature as printed in the S.A.E. Standard on Automobile Nomenclature were revised at the October Meeting of the Electrical Equipment Division. The changes are as follows:

Page K4, Group 1.—Change "Camshaft ignition-distributor gear" to read "Camshaft timer-drive gear"

Page K8, Group 2.—Change "Breaker-contacts" to read "Movable breaker-contact" and "Stationary breaker-contact"

Page K10, Group 2.—Insert, "Starting button" as third term to provide for mechanical or solenoid starting mechanisms

Insert, "Starting-ignition switch," to describe the type of switch having a single lever that is turned to one position to crank the engine and to turn on the ignition. The lever in this type of switch is thrown back by a spring to the "Ignition-on" position as soon as the engine is started

Insert, "Current-voltage regulator" following "Voltage regulator" so as to include this type of regulator

TRACTOR TESTING FORMS REVISED

Correction Factors Changed to 29.92 In. of Mercury at 60 Deg. Fahr.

At the Semi-Annual Meeting of the Society the report of the Agricultural Power Equipment Division on Tractor Testing Forms was adopted, but was withheld from publication in the S.A.E. HANDBOOK owing to the desire to correlate the correction factors used with those specified in the present Engine Testing Forms. The Engine Division considered the tractor and the engine testing forms at its October meeting, and it was generally agreed that the correction factors should be uniform. It was, therefore, recommended that the factors in the tractor testing forms should be changed from 28.60 in. of mercury at 70 deg. fahr. to 29.92 in. of mercury at 60 deg. fahr. and the basis for the belt-horsepower rating changed from 90 to 85 per cent and the basis for the drawbar-horsepower rating changed from 80 to 75 per cent to offset the changes in the correction factors.

NO. 00 FLYWHEEL HOUSING ADOPTED

Owing to the demand for internal-combustion engines of considerable power in industrial work, it was recommended at the October meeting of the Engine Division that the S.A.E. Standard for Flywheels and Flywheel Housings be extended to provide for larger engines than are used ordinarily in automotive practice. The Engine Division therefore, developed a larger size of housing, the dimensions being as follows:

PROPOSED DIMENSIONS FOR NO. 00 FLYWHEEL HOUSING

Inside Diameter, in.	31.000 to 31.010
Outside Diameter, in.	34¾
Bolt-Circle Diameter, in.	33½
Bolt-Holes	16
Bolt-Hole Diameter, in.	17/32

These housing dimensions were approved by the Division and will be proposed for adoption as an extension of the present S.A.E. Standard for Flywheels and Flywheel Housings, p. A1 of the S.A.E. HANDBOOK.

The Engine Division recommended also that all specifications covering the cone-clutch type of flywheel or housing be cancelled, as this type is now practically obsolete.

AUTOMOTIVE RESEARCH

The Society's activities as well as research matters of general interest are presented in this section

BUSY SEASON PLANNED FOR 1925-1926

Research Committee Outlines Full Program for Department for Coming Winter

What are good riding qualities? How much of the discomfort suffered in an automobile is caused by actual physical phenomena and how much by the rider's frame of mind? Are all movements equally objectionable and is it a correct premise to say that everything that reduces motion increases comfort? Or are some movements worse than others, and if so what is the standard of amplitude, speed, acceleration or direction by which they are judged? How should riding-qualities be determined? By experiment with an actual car on the road; with an apparatus in the laboratory; or with a combination of the two, an apparatus that reproduces in the laboratory the conditions on the road? What instruments can measure vibrations of such small amplitude and high frequency as are likely to affect the riding-qualities of an automobile?

These were some of the questions that confronted the Riding-Qualities Group of the Research Committee at its recent gathering in New York City. This meeting occurred in conjunction with that of the main research body to take stock of past accomplishments and draw up a program for the 1925-1926 season. The expectation is that during this period the research projects of the Society will be greatly furthered.

New Accelerometer and Vibrating Apparatus Described

During the riding-qualities session, R. W. Brown, of the Firestone Tire & Rubber Co., discussed one of the ramifications of this widespread problem. At the invitation of the Committee, he presented and demonstrated a single-element portable accelerometer, developed at the Firestone plant. Mr. Brown characterized the instrument as a trial design in the course of the evolution of a small, accurate, portable instrument that can be placed in a motor car, and, after passing over any road, give a reading proportionate to the discomfort caused the passengers. The instrument counts the number of accelerations greater than a predetermined value which occur in passing over any road. Preliminary tests indicate that for conditions known to give poorer riding-qualities, the number of accelerations recorded will be greater. For instance, the accelerometer demonstrated was set at ½ *g*. On a given stretch of road it recorded 400 accelerations greater than this value; over the same stretch of road, with the same car and at the same speed, but with the tire pressure 5 lb. greater, 420 accelerations greater than ½ *g* were recorded.

The actuating portion of the instrument is machined from a solid block of tool steel and consists of a frame supporting a weight through the medium of an extremely short cantilever spring, a pair of contacts, one mounted on the frame and one on the weight, and a stop mounted on the frame and arranged to limit the motion of the weight. When the frame is subjected to a vertical acceleration, the weight tends to lag behind the movement of the frame, and at a certain point, depending upon the loading of the cantilever spring, the contacts open and actuate the counter. Since the movement of the weight is restricted to approximately 0.001 in., the contacts open under an acceleration the value of which depends upon the initial load imposed on the cantilever spring by the adjustment of the stationary contact. The only problem that then remains is to secure a counter that will operate in a relatively small time-interval and upon small energy-input. Such counters have been developed for other scientific purposes, and one of these was used on the accelerometer under discussion. The number of elements in the accelerometer can be increased, Mr. Brown pointed out, with each one set for a different acceleration. For the practical measurement of riding-qualities, he recommended an instrument with five elements, the lowest set at ½ *g* and increasing in geometrical progression to about 2 *g*, although he believes that accelerations of more than 1½ *g* are unusual in a motor car.

One of the essential qualifications of an instrument to measure riding-qualities is said to be embodied in the accelerometer described, the ability to operate within extremely short time-intervals. As an example of the shortness of time in which displacements occur on the road, Mr. Brown gave some figures obtained from tests on a truck chassis. The chassis was successively equipped with solid, cushion and pneumatic tires and was run over an obstruction 1¼ in. high and 3 in. wide at a speed of approximately 15 m. p. h., and with the solid-tire equipment, the acceleration on striking the obstruction took place in approximately 0.014 sec., and the maximum acceleration on the first road-impact after passing over the obstruction occurred in the same interval. The time required for these same accelerations to take place is somewhat greater in the case of the cushion tire, and still greater in the case of the pneumatic.

Approaching the subject from the opposite angle, the human reaction to motion, Dr. H. C. Dickinson explained an apparatus constructed at the Bureau of Standards to ascertain what vibrations cause discomfort. This vibrating chair, resembling an automobile seat, to be used either with or without a cushion, can be agitated up and down, from side to side, or backward and forward within a range of from zero to 0.05 in. It is driven by an adjustable-speed motor having a range of from 300 to 2000 r. p. m., and both the speed and amplitude of the vibration can be changed at will by the operator. This is a revised form of an apparatus previously built and has been made more accurate and adaptable and of wider range.

A few preliminary tests have been made and, though the data available are not sufficient to form the basis of definite conclusions, they indicate what may be expected. In the experiments the effort was made to determine the point, in both amplitude and speed, at which the vibration was distinctly uncomfortable. Several trials were made at each speed and amplitude and the "subjects" were found to be fairly consistent in stating the conditions under which discomfort was felt. With one person, the variation, on different runs, in amplitude of vibration designated as uncomfortable at a given speed was confined to 0.001 in. Individuals did show irregular sensitiveness, in the sense that the amplitude of vibration designated as uncomfortable did not vary in any set proportion with the speed. A greater toleration for transverse than for vertical oscillations was also evident.

The suggestion was made that, in arriving at a standard of riding-comfort, this or a similar apparatus with a wider range to cover all possible speeds and amplitudes of motion in a motor car should be used. A hundred or more persons should be subjected to experiment and from the figures obtained the sensitivity curve for the average person could be plotted against speed and amplitude for the entire range of motion. Such a curve would show clearly the points of sensitivity and non-sensitivity. When this is done, an acceler-

ometer such as that described by Mr. Brown might be constructed with three or four different elements, each recording independently. To multiply the various numbers obtained from different periods might be desirable, thus arriving at a rational sensitivity-curve. The apparatus now at the Bureau of Standards can cover the range of vibration periods of the chassis-structure. Motions due to ordinary spring-deflection would require an apparatus of wider range.

Another suggested means for attacking the problem was first to discover by tests what motions are likely to occur in a vehicle on the road, and then to reproduce the conditions in the laboratory. Here experiments could be made with controlled speed, weight-distribution and spring-action to ascertain the limits of riding-comfort. Another proposed method of procedure is to carry a number of persons in different cars over the same road at the same speeds and find which vehicle is the most comfortable. The determination as to what motions are disagreeable could then be made under actual riding conditions. The results of any one of the methods outlined should, it was pointed out, check with those of the other two.

For the solving of the problem it was suggested that companies manufacturing parts especially affecting riding-qualities be asked to undertake investigations relating to their respective products. The program for the immediate future involves an increase in the personnel of the present Riding-Qualities Group to include those directly interested in the problem, frequent meetings of the group, and the following up by the Research Department of any new developments outside of the Society's activities.

Highways Committee to Study Tire-Impact Tests

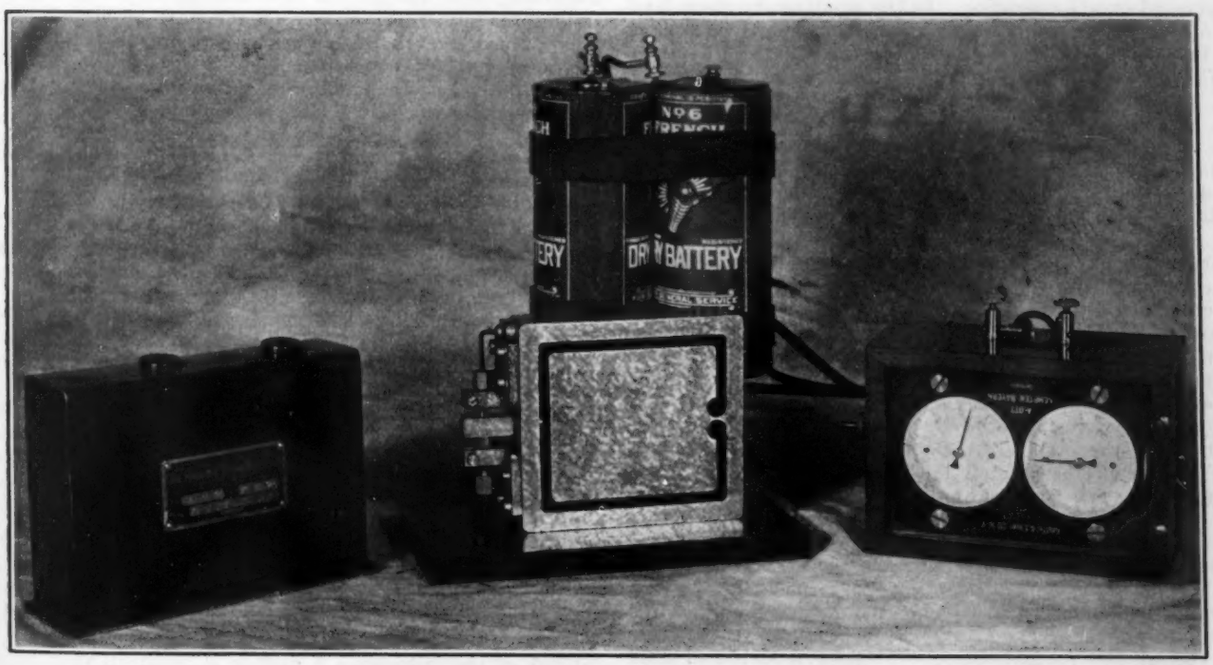
Closely allied to the riding-qualities research is the investigation of tire-impact forces which has been carried on by the Bureau of Public Roads, with the cooperation from the Rubber Association of America and the Society. The tests have now all been made, but before the results are given general publicity, they are to be carefully surveyed. For that purpose a sub-committee has been appointed, consisting of James A. Buchanan and G. P. St. Clair, representing the Bureau of Public Roads; E. O. Dietrich and R. B. Day, the Rubber Association, and Dr. H. C. Dickinson and Benjamin Liebowitz, the Society. After this sub-committee has completed its findings, the final report on the impact tests will be prepared.

Collecting of Winter Oil-Samples Set for February

The investigation of the causes and effects of crankcase-oil contamination, through analysis of oil samples from cars run by owners throughout the Country, is now at the half-way point. The collecting and analyzing of summer samples have been completed. The findings are being transmitted to the participants, but they are not thought sufficiently comprehensive to be of general interest. They will be included, as a basis for comparison, in the report on the coming winter-survey.

In general, the procedure in connection with the winter sampling will follow the same lines as the summer survey, so that a comparison can be fairly made. The oil to be collected will be that used in cars between Jan. 1 and Feb. 15, 1926. The changes made in procedure are designed to render the results more inclusive, to obtain more specific information, and to lessen the expense of the project by such expedients as the first survey indicated can be safely used. Under the first heading comes the increase by about 15 per cent in the number of cooperating service-stations. However, only the same eight makes of car are included. The list of cities from which samples are collected will remain the same.

A departure from the summer procedure is the collecting of samples of fuel as well as of oil from the cars used in the test. In the first question-sheet, service-stations were asked to indicate the fuel used, but the answers did not always furnish sufficiently exact information. With an analysis of the fuel samples available, the effect of the final factor can be more definitely gaged. Another expedient to ascertain the part played by fuel in crankcase-oil contamination and resulting engine-wear is a test planned to be run concurrently with the oil investigation to determine the effect of varying sulphur-content in fuels on an engine running under a light load. Designed also to get more specific information is the provision that, while all samples for one make and model of car are to be grouped together for composite analysis, individual samples are to be selected at random and tested. In this way a better conception of the range



Single-Element Portable Accelerometer and Counter

The Instrument Seen in the Center of the Illustration Is Machined from a Solid Block of Tool Steel. The Massive Cantilever Is Connected to a Rectangular Frame through a Thin Web Acting as a Spring. An Electric Contact Is Provided Opposite the Spring Support of the Cantilever. Accelerations Cause Breaks in the Electric Circuit Which Are Recorded through the Electric Counter Pictured at the Right. The Cover for the Instrument Is Seen at the Left

in individual differences can be obtained. The samples will be analyzed for water, dilution and ash, with iron oxide and silicate determinations only for samples high in ash. In the opinion of those in charge of the work, these findings will be as valuable as those of the previous more complex analysis and will involve less expense.

That all participants may understand more clearly our request for their cooperation, a circular has been prepared for distribution explaining the aims and methods of the investigation. Every effort has been made to enable the service-station to carry out the details of the collecting of samples. For instance, a 2-gal. container is being sent to each service-station participating in the survey. The service man is requested to draw off into these cans immediately after stopping the engine the entire contents of the crankcase of the car under test. Then he is to shake the can vigorously, and finally to take the sample of the thoroughly mixed oil. These precautions are necessary so that the samples sent to the Bureau of Standards to be analyzed will be thoroughly representative of the entire contents of the crankcase. If the samples are taken carelessly, they are apt to contain either an undue or an insufficient amount of the many ingredients entering into the composition of a used engine lubricant. For the withdrawing of the fuel samples from the crankcase, pipettes and rubber tubing are provided. On the question sheets certain points have been amplified to secure more detailed data. For instance, under the main heading as to the variation of the engine, radiator and crankcase from standard, the following questions have been asked:

(1) What kind of oil-purifying device, if any, was used?
(2) Was manifold heating different from standard?
(3) Was thermostat used?
(4) Was radiator shutter used?
(5) Was hood-cover used?

Subsidiary Problems Develop in Fuel Research

The main projects of the Cooperative Fuel Research, as stated in the Automotive Research section of the November issue of THE JOURNAL, are to determine the most suitable fuel for present-day motor-cars and to ascertain what difference in volatility is necessary to secure the same performance in winter as in summer as regards starting, flexibility, and general engine operation. In the preliminary steps leading to these experiments, many interesting points have come up. One special task was to make a final test of the apparatus being used by the Bureau of Standards in the starting-tests, to see whether this differed from commercial carbureters in any way that would invalidate the results of the tests. The comparisons between the apparatus and two standard carbureters consisted of runs at various throttle and choke-positions. In some cases, the contrasting characteristics of aviation and commercial gasolines were particularly noted. No marked difference was found between the performance of the carbureters and the apparatus, although the actual quantities of fuel required to start the engine in a given length of time differed somewhat as between the two carbureters and the test equipment. A dissimilarity was found, however, in the distribution comparison. With the original test-equipment and with one of the carbureters used, each cylinder would start in a given time with the same mixture. With the second carbureter, one cylinder started more readily than the others. A few measurements were made with this carbureter rotated 180 deg. about a vertical axis. In these tests, one cylinder still started more readily, but it was a different one, proving that the discrepancy was due to the carbureter and not to the peculiarity of one cylinder. The tests showed that the apparatus used by the Bureau gives results applicable to the standard carbureters.

Another peculiarity noted during the experiments was the varying results at different speeds. The more recent tests were run at 100 r.p.m., whereas in those reported in THE JOURNAL of July, 1925, the speed was 200 r.p.m. Consistent results were obtained when the tests were run at room temperature, but at low temperatures the findings were extremely erratic. At the mid-point, 150 r.p.m., the results were fairly consistent, and at 200 r.p.m. very consistent. Experiments are in progress to determine just why a difference exists.

Still another phase of the research on starting is the effect of oil viscosity on the break-away torque. Tests were carried out with jacket-water temperatures of 176, 68 and 50 deg. fahr., and with oils ranging from 143 to 180 sec. at 100 deg. fahr. In each of the runs measured, regardless of the character of the oils, the break-away torque was the same. However, after the moving parts were started, oil-viscosity had the effect generally expected.

Headlighting and Gears Fields for Investigation

The headlighting problem is enlisting a continually widening circle of interest, and the Research Department is endeavoring to keep in touch with the many phases of the activity. Assistant Secretary Drake, of the Department of Commerce, is in favor of having the Bureau of Standards conduct, in cooperation with the industry, head-lamp illumination-tests to demonstrate various principles and to secure their acceptance by manufacturers and engineers. Among the universities directing attention to the automobile lighting situation is the University of Michigan. Prof. H. H. Higbie and Hempstead S. Bull, of the College of Engineering, have been assigned to, and money has been appropriated for, a preliminary survey of the progress in automobile head-lamp illumination from 1915 to the present time. The matters to be investigated include:

(1) Technical features of the lens system, the housing, the incandescent lamp and the headlight as a unit
(2) Physical, physiological and psychological factors affecting the amount of road illumintion required
(3) Causes and remedies of glare
(4) Patents on head-lamps

A. W. Devine, of the Massachusetts Registry of Motor Vehicles, whose interest in headlighting is well known, is now planning a special study to determine what is considered in practice to be the top of the beam. During the winter season, Mr. Devine expects to enlist for this purpose the services of a number of men experienced in head-lamp adjustment. Industrial organizations, such as the Edison Lamp Works and the General Electric Co., are carrying out experiments for bettering head-lamps. In addition to following up these widespread lines of activity on the part of other organizations, the Research Department is keeping in touch with the work of its own committees, one investigating the subject of the optical basis of automobile lighting, and the other the fundamentals of head-lamp construction.

Many reasons for undue and excessive gear-noise have been discussed. At the recent Research Committee meeting the statement was made that sufficient attention is not paid to designing a gear for the particular type of work it is destined to perform. The tendency in selecting a gear is to pay too much attention to the convenience of interchangeability. By direction of the Research Committee, the Research Department is to compile a bibliography dealing with the mathematical basis of gear design. It will include abstracts of the articles and books listed, so that the reader can see readily the items of interest to him. This is intended to assist those who are going back to the fundamentals, the only expedient which, it is thought, will lead to a solution of the gear problem. The American Gear Manufacturers' Association also is preparing to study the situation from a different viewpoint and through E. J. Frost, its president, has expressed a desire to cooperate with the Society.

Survey of Industrial Research To Be Conducted

An important function of the Research Department is to keep in touch with the tests and investigations being conducted in industrial laboratories, and to accumulate and distribute information as to the men and facilities of this branch of the industry. A system is being planned whereby an uptodate census will be kept of the facilities manufacturers have for research, what work they are doing, to what extent the results have been published, and what data they are willing to give out for either restricted or unrestricted circulation.

Manufacturer's Reflections on the Automobile Service Field

By JOHN SQUIRES[1] AND CARL BREER[2]

SERVICE MEETING PAPER

ABSTRACT

INVALUABLE experience gained throughout the Country by competent men engaged in "servicing" automobiles is presented specifically in a series of field notes describing reported troubles and their successful diagnosis and remedy, comments being made thereon. Factory representatives, distributers, dealers, salesmen, service organizations, repairmen and owners contribute their respective portions of the information conveyed, the intention of the authors being to demonstrate that a successful field-service organization is one which has the feeling that it is a part of the factory organization, in spirit and at heart. With this attitude of mind, problems of servicing automobiles always will appear from the simple, rather than from the complex, side. Further, the attitude of the car-owner should be one of belief that he is a part owner of the plant in which his car was built. The foregoing attitudes can all be developed through the service sales-ability of the service department.

Subjects treated specifically are indicated by the following sub-titles: Servicing Is a Field of Unlimited Opportunity; the Psychology of Service; Better Cars But Poorer Service; An Ideal Instruction Book Needed; Field Experiences; Service Salesman Needed; Why His Cars Lost Power; Taking the Owner's Statement; Brake Readjustment Not Needed; Wrong Spark-Plugs Cause Trouble; Noises, Their Cause and Cure; Bothersome Engine Noises; Warning Concerning "Pirate" Parts; Where Detonation Occurs; Clutch Troubles Analyzed; No Benefits from Special Accessories; the Special-Accessory "Game"; Generalities As to Piracy; and Common Sense Is Needed.

In the belief of the authors, it is not possible to outline a major set of rules specifying the various means of locating automobile troubles. Faith in the good qualities of cars and a proper attitude of mind will enable the difficulties to be located by the most direct route.

IN discussing general automobile-service with the object of analyzing and bettering field service-conditions, the manufacturer's attitude can be only one of appeal in a cooperative spirit. So long as we are human beings, differences of opinion will exist and errors will be made. Admitting that human judgment is not infallible, mistakes on the part of the manufacturer as well as on the part of the service organizations in the field are bound to be made.

A successful manufacturer is one who has a proper organization in each department, and the same can be said of a successful dealer. A successful product is one that is properly manufactured, properly distributed and, most important, properly serviced and maintained. A manufacturer carefully designs and constructs the automobile and the dealer delivers it to the owner. From that time on, the real responsibility rests upon the service organization. When one analyzes the tremendous number of motor cars now in operation, one can readily realize the hugeness of the task of servicing automobiles in the field. No matter how well a car may have been designed and built, its reputation may be ruined in the hands of a poor service-organization. Service, therefore, is as important to a successful dealer as engineering is to the builder, the only difference being that the engineering organization affects the product as a whole, and the service organization reflects on the product mainly in a particular district. A service manager and his organization will make or break a dealer in accordance with the degree of his ability to provide proper service or maintenance. A car is sold first on the strength of advertising and salesmanship. Second, the all-important repetition of sales depends greatly upon the ability to satisfy the owner by giving him the right kind of service. A satisfied owner will sell many cars and the responsibility for his satisfaction rests mainly upon the service organization. It is doubtful if we can exaggerate the importance of the service situation.

A FIELD OF UNLIMITED OPPORTUNITY

With the rapid growth of the industry, a demand is heard from the field for many keen men in "service." The skill of the majority of the so-called mechanics may be questioned. Getting men with the right ability is a matter of strenuous education. The opportunity for service men of ability at present is unlimited. The service jobs in the field are as big as one wishes to make them and, primarily, the size of the job depends upon the initiative and the ability of the man in charge, regardless of locality. It is fully essential that he have initiative and that he "sell" his employer upon the possibility and responsibility of building up a desirable service-organization. This, along with financial support for the proper equipment and quarters, is equally important. The service-station should be as attractive to the car-owner as the salesroom is to the buyer. Basically speaking, the dealer, once properly "sold," will increase his investments in the servicing facilities and will find that his advertising disbursements will bring increased returns. This, we believe, is the keynote to service success, and is the foundation of many a successful dealer.

The situation of building-up the organization in the field and educating the mechanic is a big problem in itself and is a subject entirely separate from the one that we desire to cover. The phase that we desire to present is the picture that the manufacturer forms from an analysis of the service field. The reflection that the manufacturer obtains from the minds and actions of the average service-mechanic is that the automobile as produced is far from the perfect mechanism it was intended to be. Yet, in reality, the automobile of today, representing years of engineering and manufacturing experience, will give entire satisfaction commercially with the ordinary guidance of common sense.

Because many field service-men regard this piece of mechanism as a summation of many imperfections, this

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[2] M.S.A.E.—Executive engineer, Maxwell-Chrysler Motor Corporation, Detroit.

attitude of mind naturally leads them to seek something wrong in the structure. The illusion often leads the mechanic astray, the service managers are misguided and the car owner is overcharged and dissatisfied, which reflects on the dealer and the product. It is the fundamental that distorts good judgment in analyzing and handling various service problems. This error of good judgment is all done in good faith, but, in most cases, it is due to lack of proper guidance, knowledge or the desired experience.

This paper is confined to the practical aspects of field diagnosis of engine and of chassis trouble, as these troubles must be dealt with in the field almost wholly from the personal experiences of the men who are called upon to determine what corrective measures must be utilized.

The Psychology of Service

Before considering the mechanical aspect of service, we will touch briefly on its psychological side or, perhaps in better words, the personal contact between the owner of the car and the men who service the car. A very high degree of practical selling science is required in service work if cars are to be serviced satisfactorily and economically. Owners usually come for service in a disturbed state of mind, almost invariably feeling that the mechanism of the car is at fault. In reality, some condition may have arisen because of abuse by the owner, or some natural divergence from standard adjustments has developed through normal use. It is of the utmost importance that the service men do not permit the owner to feel unjustly that the reason is anything other than a normal, easily explainable one and need for service that lies entirely outside either the material or workmanship in the construction of the car. This is actually true within an infinitesimal fraction of 1 per cent, as modern methods of production, inspection and assembly practically preclude anything being wrong with a motor car other than an overlooked adjustment before passing the vehicle on to the owner or an acquired lack of adjustment after the owner has taken delivery. A fundamental in owner contact is that the customer should be received in clean, well-appearing surroundings by a member of the staff who does not give the impression of being a mechanic. Untidy surroundings savoring of mechanical work, or reception by a person of the mechanical type tends to exercise a repellant influence on the owner. It has been demonstrated repeatedly that it is of extraordinary value to have the owner met by a member of the staff who conveys the impression of personal equality and who accepts the owner's tale of trouble as a general explanation of an impression only and as furnishing a lead whereby to conduct an investigation and diagnosis, rather than to accept the owner's statements regarding the nature of the trouble as being definite and final. Every reason exists for the soundness of this attitude. It is usually correct, because motor-car troubles are no longer obvious except in very rare instances.

To have the owner drive the car to demonstrate the nature of the trouble rather than to take over the car for a personal check is extremely valuable to the service diagnostician, because in very many cases it will be revealed that some peculiar trait of driving is deceiving the owner. Because of this peculiar trait the car cannot function properly. Corrective measures can be applied to the owner as well as to the car. We stress this owner contact very strongly because our experience has been that a great amount of service work is done on cars unnecessarily because of owner insistence that certain things are wrong and because acceptance of the owner's dictates necessitated work being done which was absolutely not required.

Better Cars, Poorer Service

Due to the progress that has been made in the last few years in the design and construction of automobiles that are less and less apt to have characteristic troubles, the ability to service motor cars throughout the Country has deteriorated badly and continues to deteriorate. This is because automobiles need less and less attention to keep them operating properly, and service operations are being subdivided in the same manner as production operations, so that workmen have become specialists in minor subdivisions of service and familiar only with portions of the problems of servicing cars. This makes it vitally necessary that the executive staff of service-stations have men who are thoroughly expert in ascertaining the cause and the source of motor-car troubles and are able to translate this information into terms of corrective work to be done, so that the cars may not only be properly serviced mechanically but also at the proper cost.

We have not been able to develop any fixed system of "trouble shooting" because of our experience that the divergence between actual and apparent cause of trouble is becoming constantly greater. Also our experience has been that printed matter describing the possible sources of certain kinds of trouble and the possible corrections is only moderately effective, due apparently to the human resistance to acquiring knowledge by reading only. Although we utilize service bulletins to the maximum extent, we have been forced to treat them as lesson papers only, to be utilized as the foundations for oral instruction and a record of the lesson that can be referred to later if occasion requires.

As a result of past experience with distributers, service-station administration and all the practical difficulties in servicing cars that have existed since the beginning of the automobile business, we have felt it necessary to put into the field a corps of highly trained men of long and extensive experience in solving service problems, for the purpose of transmitting direct to distributers' service-stations their combined fund of knowledge plus data that are constantly given them from headquarters. As a means of keeping these men uptodate, they are called in to headquarters periodically in a group to discuss a program of service details developed from their own mechanical reports that arrive at headquarters daily. This assures that all the peculiar cases which have arisen since the previous meeting will come up for discussion and will result in thoroughly schooling the entire group. Each man will have prepared a questionnaire for submission to the conference, which is attended by engineering, production and inspection heads, so that the solutions to questions can be developed properly and understood by the entire group. Complete minutes of the conference are supplied each man before he again leaves for the field. This furnishes him with a reference work of no mean value for future needs.

After these men leave the headquarters conference and go into their respective districts, they call conferences of service managers at various central points in the respective districts to transmit the information and knowledge that has been developed at the main conference. This illustrates how strongly we feel the necessity of disseminating service information in the most practical and thorough manner, because we have found through bitter experience that the mere passing on of

technical information, no matter how complete or how well presented, does not necessarily mean that it will be properly assimilated. We feel that it is vital to be certain that the personnal attention of those who are to utilize technical information be focused intelligently upon the information and that it is also vital to us to see that the information is properly digested.

In support of our statement that the mechanical troubles of motor cars are no longer obvious nor subject to written rules for correction, some notes made by some of our field men are presented. We believe that these notes reveal that an able service man has, to a motor car, much the same relation as a skilled physician has to a patient and that, only by developing a very high degree of skill and ability in service men, by a constant process of education, are we to combat future motor-car troubles satisfactorily.

We thoroughly believe that the great majority of motor cars produced by the builder of higher grade cars today will give very little trouble to their owners unless subjected to some abnormal use or to neglect. With all the protective features of design which have been incorporated in the construction of the modern motor-car to prevent troubles occurring, which, in the past, have been expected, new and unusual troubles now develop only because perfection is never reached, but simply a change of state is involved which requires a different vision to comprehend. These notes cover to a very large extent a number of cases where the indications were that some of the common troubles, subject to easy correction, developed, but where the solution of the problem was radically different, as well as comments on their characteristic wrong diagnosis. We have brought into this paper two groups of these notes from two different men, and we believe that they are more or less truly representative of service representatives' field work generally. The first group of notes is as follows:

An Ideal Instruction Book Needed

The most important factor in connection with the delivery of reliable and efficient service is for the manufacturer to supply his distributing organization with an ideal instruction book—this refers to the ordinary car-instruction book—containing all the necessary details covering proper adjusting of ignition timing, spark-plug gaps, carbureter, carbureter dash-control, camshaft timing, clearance between valve tappets and stems and why; also clutch, battery and generator instructions, explaining the things to be done to these parts during summer and winter weather, and specific instructions as to the importance of summer and winter oils for transmissions, engines and axles. In other words, the manufacturer should first produce an ideal instruction book covering the standards of settings necessary to obtain the maximum power, speed and economy, if he expects his distributers to give to his customers the service that is built into his product.

The majority of instruction books covering a representative number of cars reflect a disposition on the part of the director of service to see that both the owner and the dealers' mechanics are supplied with all the necessary information to service a car properly. In many cases, it was a shame to tack the name of "instruction book" on what was being sent out. The manufacturer cannot expect much from the dealer organization or from the customer in the way of proper care unless his instruction book covers thoroughly all the necessary tune-up standards in connection with the engine, how these various units and adjustments should be altered for summer and for winter conditions and, sometimes, for abnormal service-conditions in exceptionally hot climates where temperatures of 115 deg. fahr. are often encountered and to the other extreme of temperatures away below zero.

Field Experiences

As an example of how perfectly good automobiles can be ruined unconsciously by a dealer's organization not acquainted with the tune-up standards, a very striking instance came to my attention in connection with the delivery of the first five new models to one of our big distributers. I followed this particular shipment through all the assembling, the final test and the approval proceedings. I checked the valve tappets to see that they had proper clearance, the carbureter settings and the choker control; finally, I rode the cars out for a mile or so and was pretty well convinced that these five cars were thoroughly good cars. However, after this shipment was received by one of our very large distributers, I received a telephone call telling me that these were the worst five cars ever received.

I traveled 450 miles to analyze the situation and, in checking with this dealer's department that conditions new cars for delivery, I was informed that the cars were received with the spark-plug gaps adjusted wrong, the ignition timing wrong and the valve tappets wrong. Upon testing each car on the road again, I was convinced that something was wrong; they were bucking badly, would not pull and it was impossible to throttle them down. Briefly, the man in charge of the new-car department was not familiar with our adjusting standards. Naturally, everything was wrong according to the standards he adopted. He had changed the ignition timing on each car, had set the tappets too close and also the spark-plug gaps. After changing all these units back to the standards of setting specified by our engineers, the managing director of this company admitted that they were the five best automobiles ever received.

Our instruction book contained all the proper standards at that time, but the excuse given for the standards they had worked to was that we did not have them in our instruction book, proving that this dealer's organization was not paying much attention to what the instruction book had to say. It required about 40 min. to find an instruction book in this establishment to prove to the men that all the necessary information was in it. As a result, this distributer found out what was wrong with his organization and called a weekly service-school meeting to discuss the adjusting standards and other information contained in the instruction book. The experience illustrates the importance of having everyone in the dealer's organization study the instruction book carefully. Every mechanic should be charged with one when he comes into the organization, and it is well for the service managers of the distributers to hold a service-school meeting weekly to get everybody properly lined-up on adjustment standards.

Service Salesman Needed

Every dealer should have a service salesman whose duty it is to sit down in a quiet corner with the new customer and go over the instruction book carefully for perhaps ½ hr. to outline the important things that he should and should not do and to call his attention to the lubrication standards when delivering the car. I believe much good can be accomplished in this way.

Having any one of a half-dozen units only slightly off from the specified standards is very apt to result in considerable misdirected effort and expense if not diagnosed properly. Therefore, to make a good job of tuning-up according to specified standards before subjecting a car to any major repairs such as the changing of piston-rings, pistons and the altering of bearing adjustments is always advisable. After this, the car should be driven at least 25 miles at a steady speed of from 25 to 30 m.p.h. to dry out the moisture accumulation in the combustion-chambers which is usually

found in the cases of rich mixture or irregular firing of engines. If a valve is not ground properly, it makes no difference what kind of carbureter or spark-plugs you have, you cannot make the engine fire properly. On the other hand, if the spark-plug gap is too wide or too close, or if the carbureter is set improperly, you cannot correct this by grinding valves. Also, if the spark-plugs are fouling as a result of these irregularities, you cannot correct the trouble by changing piston-rings.

As a result of much of the piston-ring advertising and propaganda, entirely too many piston-rings are being changed. This applies also to cylinder bores. Cases have come to my attention of cylinder bores that were reground and in which new pistons and rings were put into engines simply because a slight taper was found in the bore which the mechanic thought resulted in irregular firing of the engine. Analysis of the general situation of our dealer's showed that the trouble was again due to improper adjusting of tappets and ignition. This was proved by removing the cylinder-head on what he selected as the best performing car in his territory and checking the bores. The bores of this particular job had a greater taper than the ones that he was about to regrind. Merely by making a good job of general tune-up on the particular engine that he was about to remodel, the performance was even better than that of his best car. As a result of these findings, no further complaint was heard from this source in connection with slightly tapered bore.

The greatest care should be used in gaging cylinder-bores. The mere fact that a bore is slightly tapered or out-of-round does not mean that regrinding is necessary, because the bores are continually changing their shape slightly. This, along with the errors that the average man will make in reading an out-of-round condition, will result more often in a false reading.

In some tests made on two engines, one having chilled bores and the other standard gray-iron bores with about 34-point scleroscope-hardness, we tried to draw a comparison of the relative wear in hard and soft iron over a period of 5000 miles with the engines carrying a constant load. At the end of each day, the cylinder-heads were removed and the reading was taken the next morning on the bores to be sure that they had cooled properly. Upon reviewing the readings of these bores, it was noticed that many variations prevailed; for example, the reading crosswise on the bore would be slightly larger one day and somewhat smaller the next. This applied also to the measurement taken longitudinally. After the 5000-mile run was over, the very slight wear noticed was uniform in both types of block. Our analysis of the bores' changing their shape from day to day was that this resulted from ordinary distortion in pulling the head bolts down, which we believe prevails more or less in all engines having detachable heads.

Why His Cars Lost Power

Another striking instance of misdirected effort was brought to our attention by a small distributer who claimed that the engines would lose power in the course of a few hundred miles after changing rings. Following considerable correspondence, calling this man's attention to ignition-timing standards and to the correct adjusting of valves, he seemed unable to improve conditions. Finally we agreed to investigate the next case of an engine losing power in his district.

In following this matter through, we tested the car on a hill and found it just as was stated by the mechanic. It would not pull on a hill 1 mile long although, when in good condition, the car would go over the hill at 25 m.p.h. on high gear. Assuming that this man had followed our tuning standards, we checked the car for brake drag and several other minor items without going into any major repairs. Finally, we started a recheck on the adjustments, although he claimed they were all made according to our standards. We first found the ignition late. After correcting this, the performance was improved from having to change down to low gear on the hill to just barely going over on high. Our next step was to check the valves. We found these set entirely too close, which necessitated regrinding. After a good job of grinding-in the valves and making proper tappet-clearances, this car topped the hill at 25 m.p.h. with no apparent effort. The mechanic was troubled at the results obtained and over the fact that he had not done his work properly. He still remained very doubtful about piston-rings, but finally admitted that they had been fitting tappets particularly close because his customers insisted upon it. We have received no more complaints from this source referring to lack of power and necessity of frequent changing of piston-rings.

Piston-rings are "no cure-all," although the pictures in piston-ring advertisements and the stories that go with them suggest the thought that, like much of the patent-medicine propaganda, the piston-ring is the cure-all for all ailments. In fact, I believe the average piston-ring is good for at least 50,000 miles so far as power is concerned although, in many cases, it is necessary to change rings more frequently because of excessive oil-consumption that usually results after the cutting edges of the face of the ring that make contact with the cylinder bores wear off. If it were not for this, it would not be necessary to change piston-rings during the life of the average car unless they have been scored through lack of water or oil.

Regarding the proper clearance of tappets, every mechanic should write in his notebook that a tappet once adjusted too close so as to cure tappet noise will develop excessive clearance perhaps in the course of 500 miles and will then be much noisier than if it had been adjusted with the proper clearance at first. This is caused, first, because the valve, being held off its seat on the block, does not cool properly; it will change its shape and form a scale under it which will lift the valve up several thousandths of an inch from the tappet. Second, in many cases the face of the mushroom of the tappet or the face of the roller in the other type of tappet will score badly, due to the fact that the tappet is being pressed against the camshaft all the way around by the valve-spring pressure, instead of riding free with clearance on the base-circle side where it effects its cooling. With this spring pressure exerted against the tappet all the way around, a very high temperature develops which results in discoloration and in causing metal to wipe from the tappet onto the cam. This is often mistaken for a faulty camshaft; therefore, nothing but trouble is accomplished by a close tappet-setting. In other words, if you ground-in the valve and set the tappets too close and ran 25 miles, it would be foolish merely to run the tappets down; the proper thing to do would be to grind the valves again, then to set the tappets with proper clearance and let them alone. Tappets do not wear very quickly; in fact, they change only a few thousandths of an inch in the course of 10,000 miles when properly set. In many cases, when set too close, the wear usually is excessive and they will change markedly in the course of 500 miles. Thus it is easily seen that the correct tappet-clearance and careful grinding of valves is of great advantage in obtaining the maximum power that is built into every engine.

Taking the Owner's Statement

Another great evil that service managers must contend with is the car-owner's statement regarding the performance of his engine. Recently, one of our big distributers stated that he had changed rings and had done many other things to correct oil trouble, that is, excessive oil-consumption, without getting results, be-

cause the owner claimed to get only 125 miles per gal. After checking this car, we found the wrong make of rings installed in the engine and, after installing our rings, we turned the car back to the customer and asked him to check back with us in a few days to see what results had been obtained. After 250 miles of driving, he came back, stating that he was now getting 400 miles per gal. and still was not satisfied. To obtain a more accurate check, we asked this man not to put any oil in his engine, but to come back to us for his oil, so that we would be able to judge the actual consumption. We drained the crankcase of his engine, put in 1 gal. of fresh oil and asked him to come back after 1000 miles. He did not want to do this, but wanted the mechanic to go into his engine further at once. However, we finally prevailed upon him to do this for us. After 500 miles of driving, he was so pleased with the results that he came in to tell us that his car appeared to be using hardly any oil. We drained off the contents of the crankcase and our check showed that it was running 1200 miles per gal.

The foregoing is a case in which a great amount of misdirected effort might have been resorted to if we had not stopped to check-up. It shows that it is not advisable to jump at conclusions. It is very easy to carry on a little experimental work along these lines without any waste of time or cost to either the car-owner or the dealer. Simply by keeping a record of the oil-consumption mileage over a 1000-mile run, one can determine very closely what it might be necessary to do in the way of repairs.

It may sound ridiculous in this day and age to state that mechanics have been found changing clutches because a cylinder was missing or had cut-out entirely, but this is an absolute fact. Mechanics who do not know their business are likely to pull the propeller-shaft, rear-axle gears and clutch-and-transmission parts to find the knock or clatter that develops in the drive-line when one cylinder is missing fire. I have actually experienced cases of this myself. The most striking instance was a case out West in which the mechanic was about to change the clutch for the third time. We changed a spark-plug in this car and the trouble was cured.

Service managers should maintain very close contact with the factory in connection with summer and winter lubrication oils for transmissions, rear axles and universal-joints, as well as for the engine. In many cases, very little attention is paid to the oils recommended by the manufacturer. In most cases, the oil salesman seems to be able to sell many dealers almost any kind of oil, and this practice results in much irregular performance. For example, gear oil that has a high soap-content will result in considerable foaming and poor lubrication; also, in having the oil level build-up and work-out through oil retainers onto brake-drums and, in the case of the transmission, in having oil splash out under the floor-boards and onto the emergency brake when it is located on the transmission. In many other cases the ordinary summer gear-oil congeals and results in hard starting and lack of fuel economy in very cold climates; also, it fails to flow freely through the return holes located at the oil slinger and has been known to cause transmissions to drain completely through their bearings.

Brake Readjustment not Needed

The service line-up for changing brakes, adjusting, truing-up bands and putting on new linings is another item of very great importance; also, the kind of lining that the dealer uses. He must in all cases follow the engineers' specifications by using the proper material, and must make certain that it is put on in the right manner. If his tools, his fixtures and his mechanics do their work right, very little is left for the owner to do toward wearing-in brake-bands. In fact, with present-day design and manufacturing methods, little excuse exists for having to readjust brakes frequently. At slight expense, the dealer can supply himself with a few tools that will help him shape-up the band after relining it, before it is put back on the car. The brake-drum from an old broken wheel can be filled with cement or lead and used for a rounding-up fixture on the bench. It is important that the drum be filled with lead or with cement to provide a solid backing for shaping-up the bands. This operation cannot be done easily on the car, because brake-drums ordinarily are very thin and, instead of having the band respond to the tap of the hammer, the break-drum will spring. This eventually spoils the shape of the brake-drums and makes it impossible to get good brake-performance.

The battery and the electrical system should be given serious consideration, and every mechanic should understand a few necessary things in connection with them. For example, many cars need a higher generator charging-rate for the heavy winter loads. In all climates this means early darkness and, in the northern sections, cold starting. Also, in connection with batteries, the distributers' new-car department should be lined-up to see that the batteries are mounted securely in their cradles and that the terminals are coated with vaseline and securely clamped to the battery terminal-posts. Too little attention is paid to this very important item. Even the battery station slips on this occasionally, because cases have come to my attention in which, immediately after having a battery recharged, the lights would be dim and the starter would not turn over simply because the cable terminals had not been cleaned. The battery people cleaned the terminal post on the battery but failed to scrape the surfaces on the terminal clamp of the battery cable and the ground wire on the car.

Mr. Squires' Remarks on Significant Phases of the Foregoing Text

Before continuing with the second group of notes from the field, several cases reported by Mr. Breer, whose experience in engineering has brought him into contact with interesting mechanics' errors from that angle, are of interest. Reports made to him of so-called improper functioning of cars engineered by his department naturally are checked-up closely, with the obvious idea of correcting, in future cars, any faults that may develop in cars now in actual road service.

We have cited the case of the report of lack of power developing in an engine, in which case the field service-department had drawn the conclusion that it was necessary to change rings and do considerable reconstruction work to get the normal power from the engine. This analysis probably was based on the opinion that, if the ring-gap opens-up, a material loss of power must result. The opinion probably was initiated by some piston-ring salesman who sold gapless piston-rings. A biased attitude of mind entirely distorted the mechanic's judgment and caused him to overlook some of the fundamentals of the relationships of various parts that might be main causes of the complaint. In this particular case the spark-timing, the spark-plugs and the clearance of the tappets were the offenders. In reality it was just a simple job.

Another example was the case of a car-owner who, in touring through northern Michigan, experienced extreme difficulty in pulling through heavy sand in that his engine, after a short interval of lagging, seemed to backfire through the carbureter. The operator had much difficulty on his trip, and often the car balked and stalled apparently due to the backfiring. Upon returning to Detroit, the driver went to one of the many

service-stations established for this particular make of car. He took the service man out where he met similar conditions of hard pulling. Immediately upon demonstrating what happened, the service man expressed the opinion that the trouble was due to carburetion and that the carbureter, a fixed-jet type, was one of those "fandangle" devices that he could do nothing with. This service man showed his dislike for the device and offered no further assistance. In brief, his analysis was that the carbureter had a lean spot that was inherent in its structure. The car-owner, not satisfied, went to several other established service-stations and was told the same story. Naturally, this owner was very much discouraged and disappointed with his automobile. Indirectly, our factory service-organization learned of the difficulty and the owner was requested to bring his car to the factory. We found him much upset. He said he was through with the automobile and if we wanted to do anything with it, it was up to us to get the car and deliver it back to him. In his state of mind the value of the automobile had vanished.

Where the Trouble Lay

Some time previous to this, the superintendent of the spark-plug plant that furnished spark-plugs to this particular company thought that he could save money by eliminating what he considered an unnecessary operation, that of cutting off the center electrodes to the length as called for in the drawing. The result was that some spark-plugs came to the car builder with long center-electrodes that overhung the side electrodes from ⅛ to 3/16 in. The action of this particular spark-plug in the engine was that, in driving the car under heavy pulling conditions, the center electrode, due to its length, heated-up sufficiently to ignite the incoming charge before the inlet-valve was closed. The result was that a back-fire through the carbureter occurred. This back-fire was of a muffled type and was not the sharp bark that is experienced through lean carbureters. Upon removing the spark-plugs, we found that the gaps of the plugs were opened-up from 0.04 to 0.05 in. and that the electrodes were too long as has been explained. All we did was to clip the electrodes to the proper length and set the spark-plug gaps. It was hard to realize what a difference this made in the performance of the automobile. The car would now perform at low speeds and would continue to pull in heavy sand without backfiring. The owner was well pleased and became enthusiastic about his automobile. Instead of a knocker, he became a booster.

Primarily, the foregoing illustrates three points of view. First, the car was foolproof in that the carbureter could not be adjusted out of reason; in other words, it could not be affected to the extent of cooling the spark-plug through over-richness. It is true that the customer was exasperated, but the mere fact that he was forced to come for service was illustrative of foolproofing to the extent that the owner could not do other damage to his car by setting his carbureter extremely rich. Further, it illustrates the possible errors due to the human equation in manufacture: namely, the man who was going to save money by saving an operation on the spark-plug, and, lastly, it illustrates that the serviceman's attitude of mind was that of condemning something that he apparently disliked due to the fact that he could not render an easy judgment. His attitude of mind biased his good judgment or common sense in the simple form of a check-up. It is true that he might not have found the longer electrode; but, in checking-up the details, he would have found excessive spark-gaps which at least would have cured the extreme difficulty of having the engine cut-out entirely after demonstrating with a few so-called lean backfires.

Another common trouble that seems to fool many mechanics due to their lack of knowledge is complaint of unevenness of operation in idling or ordinary driving or lack of power in extreme pulling up hills. One decides that the owner should have new piston-rings; another states that the valves need regrinding; a third attempts to adjust the carbureter; a fourth claims the trouble to be more or less inherent due to general wear-and-tear; and so on. In reality, the trouble usually dwindles down to nothing more than improperly set tappet-clearance. The overlooking of this simple fundamental has been the cause of many unnecessary repair bills that were paid by the owner. The clearances established by the factory are determined scientifically and are established to take care of a wide range of conditions. It is true that, sometimes, a particular cam may cause more noise than the other cams, and immediately the tappet is adjusted to quiet it. Tappet clearance in its guide and wear of the tappet face very often are regarded as factors of the noise.

All engines must have clearance in their valve mechanism, regardless of whether the valve is of the overhead or of the L-head type. Fundamentally, when the engine is warmed-up, the difference of temperature of the various parts causes a difference of expansion; consequently, when the valve is subject to an extreme amount of heat, this expansion must be allowed for; such practice is established by the engineers of every motor-car builder and recommendations are made accordingly. These recommendations are often disregarded, either intentionally or unintentionally. They are disregarded intentionally to quiet a mechanism, and unintentionally due to ignorance, because the person does not know the proper procedure for establishing the setting. Service salesmanship should be applied in the fussy cases, for it is far better to tolerate an imaginary harmful noise rather than lash the tappet.

Wrong Spark-Plugs Cause Trouble

Another example came to our attention recently when a car-owner on his own initiative desired to break a speed record between Chicago and Detroit. After his first attempt he came in with the complaint that, after the car was driven at high speeds for a short interval of time, the engine began to miss badly and, to stop this missing condition, it was necessary for him to slow-down to lower speeds for an interval and then speed-up again. His analysis showed difficulty with carburetion. The service-station sent him to the carbureter manufacturer, who tested the carbureter and found no trouble. This case came to our attention and we checked the setting of the tappets and the ignition. In the latter process it was found that he had corrugated porcelain spark-plugs in his engine, as recommended in another territory. These were sold to him as the right type of spark-plugs to use. With this corrugated plug, in many engines, under heavy running, the porcelain becomes red hot, preignites the charge and causes engine miss and a lack of power. This illustrates how a small factor such as a spark-plug enters into a peculiar difficulty in a way that often can be easily misinterpreted. So often, the factory's recommendations as to the type of spark-plug to be used are disregarded, the arguments given by various salesmen in the field are listened to and so-called "gyp" parts are used or misused due to the mistaken

impression that the factory's judgment probably is incorrect. Under this same class of field salesmanship, numerous other instances can be found.

Another case found often, especially in hilly districts, is an owner complaint that his car does not perform over a given hill as he expects it to. The service man hastily assumes that the source of trouble is in the powerplant, but later it is found in the brakes, due to the fact that somebody had adjusted them so that they drag.

We have seen cases where the service-organization brought cars into Detroit from points several hundred miles distant, the complaint being of an inherent noise in the form of a hum that comes and goes. The statement is made that weeks had been spent in trying everything to overcome the trouble. The attitude of mind is that something complicated and fundamental is the cause of the trouble. We found it to be nothing more than that the license plate had been allowed to hang too close to the radiator, at an angle; in other words, it was merely an air-fan noise caused by the peculiar position of the plate. This particular thing has happened, not only in one instance, but a number of times.

In another case a service-organization and an owner complained of axle noises. Sometimes it was real axle noises and at other times it was front-axle wheel-bearings. At speeds as low as 8 or 9 m.p.h., a particular groan would pass through the chassis that gave one the feeling of a tight bearing or trouble due to some misalignment. Analysis revealed it to be nothing more than the knobs of the non-skid tread on the front wheels that paddled on the road and caused the trouble. This trouble was so misinterpreted that the remedy took the form of readjusting rear-wheel bearings and so on down the line. Much time and money were wasted due to this attitude of mind, to say nothing of the damage probably done by upsetting adjustments that were correct. The elimination of the difficulty was accomplished by forcing the tire manufacturer to change his tread. This was accomplished by alternating knob contact on the ground.

We feel that, in many cases in which the owner complains of a particular noise being annoying to him, it is not the noise that worries him so much as it is that he imagines something must be wrong with the mechanism and that damage is being done that will impair the life of his automobile. The conscientious service department often accepts the owner's statement for its full value and takes upon itself much unnecessary work that ordinarily could be avoided by a little timely explanation of what was going on, especially when no damage is being done.

Noises, Their Cause and Cure

The subject of noises is further considered here in the second group of field notes reported by one of Mr. Squires' men. The high spots of his findings are that noises from various sources frequently are associated with some noise known to exist. Operators often believe that all noises in their vehicles are due to some one thing, and complain because the vehicle has been repaired to eliminate the noise and that it still exists. Many noises might have been overcome, yet the presence of another noise results in the owner's verdict that the same noise still exists.

Second Group of Field Notes

A case was recently brought to our attention by one of our distributers in which a noise thought to be from the timing chain was so great that he was reluctant to attempt to correct it. Investigation disclosed a grease noise in the transmission which was easily overcome by restricting the transmission vent. A pronounced chattering noise in the vacuum tank was corrected by eliminating excessive clearance at the joints and pivots in the operating mechanism. A slight chain hum readily responded to adjustment.

Rear-axle drive-gears are blamed for many other noises, including engine-period, timing-chain, engine-gear, road, transmission-gear, grease, clutch, and propeller-shaft noises and body-rumble. Other noises are caused by vibration-of-the-muffler, muffler tail-pipe or other sheet-metal parts.

Complaints about vibration usually are complaints on noise. Repairing and tightening to overcome movement of loose and drumming parts usually is effective in overcoming this complaint. One very obstinate complaint of vibration, which is somewhat typical of this class of complaints and which was reputed to have been worked on by many men without improvement, was corrected by replacement of the muffler and tightening of engine supports, floor-boards, doors and windows. Drumming of other sheet-metal parts also is a frequent cause of vibration complaints.

Mechanical noises are sometimes mistaken for detonation, such as piston-heads and piston-ring lands slapping on the cylinder bores, even while comparatively new, caused by sudden expansion of the pistons due to overheating or other abuses, thereby leaving the head and the lands relatively too large for the remainder of the piston. These noises will eventually disappear due to wear of the head and the lands, reducing them to proper clearance.

Sometimes pistons that have been installed in worn bores without the bores having been reconditioned will wedge in the smaller part of the cylinder bore and cause noise that is very difficult to locate.

Wristpins are blamed for all kinds of engine noise. Many workmen replace wristpins first, then look for the real cause of the noise. Replacement of wristpins frequently makes the engine noisy due to insufficient wristpin clearance or misalignment of the connecting-rod.

The lack of a rapid and accurate checking jig for connecting-rod and piston alignment is often felt. A connecting-rod aligning-jig is needed to handle the entire assembly without dismantling it and should test for accuracy of piston cross-bore, location of the connecting-rod upper-end clearance at piston bosses, alignment of the piston for the cylinder bore and connecting-rod twist.

Removal of the piston from the connecting-rod assembly for individual checking is impractical because of the time involved, the danger of springing the connecting-rod during assembly and because of the accumulation of errors in the whole assembly which results in appreciable misalignment.

Elliptical bearings pinched at the joint are responsible for peculiar engine noises that are very difficult to locate. This noise is apt to occur as a dull thud on a light load or during a very light acceleration.

Intermittent noise that is affected by changing the load or speed of the engine can be located by working the pistons first in pairs and then by threes of the respective ends; that is, for a six-cylinder engine, first working Nos. 1 and 2, 3 and 4, 2 and 5; then working Nos. 1, 2 and 3 and, later, 4, 5 and 6, first noting whether sound is lessened by increasing or decreasing the load on the engine. In either case it is easy to determine which pair affects the sound, then which end affects the sound; then, finally, which one of the pair in that end of the engine.

A very obstinate squeak that had been in a car for several weeks and defied the efforts of many men to locate it, proved to be caused by insufficient end-play at the crankshaft. The fit was so tight that the surface would run dry and squeak, yet would not score

or burn because of proper lubrication of the adjoining parts and good dissipation of heat from this point.

Bothersome Engine Noises

Excessive end-play in the crankshaft and in the camshaft is also apt to cause troublesome engine noises; in the former case, particularly, if the upper ends of the connecting-rods are close enough to the piston bosses to permit contact at this point. Over-running valves, weak valve-springs and sticking valve-guides are responsible causes for a great many peculiar engine noises.

Noises can occur in the engine lubricating-system. These include noises such as slapping of the oil relief-valve, pulsation of the camshaft or humming from the oil-pump gears.

Shortage of power is a frequent complaint and one that causes serious concern to service men. A surprising thing is that, occasionally, a new engine is found which will pull better at slow speeds than any of the seasoned engines of the same model. This probably is due to lack of compression leaks and to the character of the surfaces of the pistons, the cylinders and the rings. With a new engine, superior lubrication might exist at the pistons, due to the minute oil-pockets in the pistons and in the cylinder-walls and to practically total lack of blow-by.

Improper spark-timing probably is the most frequent cause of complaint of insufficient power, and the spark is more apt to be late than early. In one case, an automobile distributer complained so much about shortage of power in his demonstrating car, stating that none of his service men were able to make the car perform satisfactorily, that a representative was sent from the factory to the distributer's establishment at a distant city. He found practically nothing else wrong other than that the spark was about 30 deg. late.

Burnt or sticking valves cause loss of power, not only from the compression leaks but from the high temperature of the valve heads. Valves seem to stick worse in their guides in the Puget Sound district than in any other district in the Country, seemingly due to climatic and to atmospheric conditions in addition to the heavy grades encountered there.

Warning Concerning "Pirate" Parts

Pirate parts often are responsible for serious complaints of shortage of power. Factory investigation of a complaint of this nature, which has recurred on several occasions and which was reputed to have been repaired under the supervision of several competent men in the distributer's organization, disclosed the trouble to be due to pirate pistons and piston-rings. Installation of properly fitted standard pistons and rings and a conventional adjustment and tuning-up of the engine, brought its performance up to standard. A back check on this car after several months of daily performance showed continued satisfactory performance.

Dragging brakes consume considerable power and will make a very noticeable difference in the power of a car at slow speeds on a steep incline, especially after fast driving in hot weather.

The effect of long hard driving in hot weather is often overlooked by the operator of the vehicle. Brakes drag, engine oil thins out, valve clearances are reduced or are taken-up entirely and the entire fuel-induction system is apt to be overheated. All these factors have a marked effect on reducing power performance of the vehicle.

Weak ignition or improper spark-plugs are apt to cause the workmen to set the carbureter extraordinarily rich to keep the engine firing properly and keep it sufficiently responsive; this results in insufficient power and other troubles concurrent with over-rich mixtures.

Excessive spark-plug gaps have somewhat the same effect as weak ignition and may result in shortage-of-power complaints due to missing during acceleration or on a heavy pull. Shortage of power due to weak ignition is most apt to occur in hot, humid climates. A simple but frequent cause of the complaint of shortage of power is insufficient opening of the carbureter choke.

Where the Detonation Occurs

Detonation is frequently the cause of loss of power and must be obviated before the power performance can be brought up to standard. The installation of an additional cylinder-head gasket to overcome detonation has the opposite effect where the Ricardo type of combustion-chamber is used. Lifting the cylinder-head for this type increases the volume between the piston and the flat portion of the cylinder-head; under certain conditions, this results in increased detonation.

The common impression that detonation can be overcome by the use of a rich mixture is questionable. The rich mixture gives a lazier combustion that is less apt to cause pinging for a while, but it generates carbon much more rapidly and the carbon eventually causes worse detonation than before. The leaner mixture keeps the combustion-chamber cleaner and more free from carbon, and it reduces detonating tendencies; whereas, a richer mixture causes detonation tendencies to increase rapidly.

Early carbon formation in the Ricardo-type head after the combustion-chambers have been cleaned seems to have a catalytic action. It has been observed that, in a type of engine in which high compression is used, that is, high for commercial work, pronounced pinging is apt to occur immediately after the engine has been cleaned, valves reground and carbon removed and that, within 100 miles of ordinary driving, the pinging will be very much less.

Clutch Troubles Analyzed

Excessive clearance at the clutch pilot-shaft causes failure of the clutch to release properly and, in certain designs, will result in a squeak while the clutch hub rolls in the driving teeth. Proper clearance between the clutch release-bearing and its operating fork is very important and should be checked at the bearing rather than judged by the movement of the clutch pedal. In designs in which a compound-leverage or toggle connections are provided between the pedal and the release-yoke shaft or the release-fork shaft, play existing between the shaft and the lever would have to be subtracted from the pedal movement before the actual lash could be determined. This makes it imperative that the lash between the fork and the bearing itself be measured and the pedal set accordingly.

Failure of the clutch to release and the clashing of the transmission gears are frequent service complaints and, in many cases, are due to the method of operation rather than to mechanical defect or adjustment. However, several things can occur to make the clutch release improperly and the gears difficult to shift.

To provide a clean release of the clutch the pressure plate must pull away from the flywheel absolutely parallel to it and, with multiple-disc clutches, the intermediate driving-disc must be free to move easily and the driving disc or discs must be free to move easily on the shaft or the hub. Discs warped from overheating, or sprung from rough handling, cause improper clutch-release action.

Excessive play at the clutch shaft-bearings, particularly the clutch pilot-shaft bearing, also can cause the clutch to release improperly, particularly during a partial release.

An interesting case of transmission gears slipping out of mesh occurred in Mississippi. This car had been slipping out of gear for several months and had had every part between the engine and the rear axle replaced at least once, the final repair prior to locating

the trouble being the installation of an entire clutch and transmission assembly from another car which did not jump out of gear, yet the car continued to have this trouble and the local service manager told the factory representative that no one in the world could correct that trouble. It was an inherent fault in his opinion and would always exist in the car. The trouble proved to be improper bolting of the clutch housing to the flywheel housing. The cause of the trouble was distortion of the clutch case and the flywheel housing which threw the transmission out of alignment with the engine.

Other causes of gears coming out of mesh are radial play in any of the transmission bearings, end-play in the transmission sliding-gear shaft or main drive-gear shaft, improper meshing-alignment of the gears, insufficient tension in interlock pawl-springs, or improper alignment during heavy pulling due to springing or looseness of a part that might permit the transmission to get out of alignment with the engine, which misalignment need not be very great.

Bearing roughness and gear noise also are apt to be caused by insufficient lubrication, improper lubricants or insufficient frequency of changing of the gear oil. Some transmission lubricants contain enough acid and moisture to cause rapid deterioration of transmission parts, particularly ball-bearings.

Some transmissions have a sufficiently large vent to permit the sound of the grease running to be noticeable from the driver's seat, especially if the vent be in the top of the transmission above the floor-board level. This sound is frequently mistaken for gear or bearing noise. Propeller-shafts that are out-of-balance cause a disturbance which is apt to be concentrated at the transmission as to the resultant noise.

Reference has been made in previous paragraphs to rear-axle noise, yet it might be well to repeat the fallacy of working on rear axles to eliminate backlash in the drive mechanism and gear-like sounds throughout the entire vehicle. Shimming of differential side-gears, close meshing of final drive-gears and tight adjustment of rear-axle bearings cannot overcome backlash noise that exists at transmission pocket gears, transmission shifting-shaft gears, in the clutch or in the propeller-shaft assembly.

No Benefits from Special Accessories

Another big problem exists in the service field which will bear analysis and which the manufacturer feels has considerable to do with the prejudiced mind of the service man when he attacks his problems. In the field, we have many accessory salesmen selling their wares. One sells spark-plugs; another sells lubricating oils, oils that will double the life of your engine, increase the power and eliminate all noise. Another has designed a special piston. Another will sell you replacement parts far better and cheaper than the car builder can supply you with and gives many reasons. Another sells you a carbureter that will make your car perform as it never did before. Then we have a lot of accessories to add. One will increase your economy by from 20 to 30 per cent and you will find a half dozen more that, by different means of attack, make similar claims. If you should be fortunate enough to put them all on one car you would not use any fuel at all.

The Special Accessory "Game"

Some years ago Mr. Breer was in the service-accessory sales-business and had occasion to install a lot of carbureters sold to car-owners. When the accessory-store salesman sold a carbureter, he always recommended that our organization make the installation and suggested to the owner the advisability of checking the ignition, cleaning out the carbon and regrinding the valves if necessary. In brief, the car got a general tune-up when applying the carbureter. The tune-up details covered briefly the few simple adjustments that are so easy to make and yet seem so easily overlooked by the average service man.

After the check-up, the new carbureter was carefully adjusted and the car performed as it had never performed before. Yet had the same amount of effort been put on the job, the car probably would have performed equally as well with the former carbureter. Of course the owner was pleased when he paid his bill, the accessory sales-department made a profit, the service department made a profit on the installation and tune-up and the owner was a booster for the carbureter. All along the line the general opinion was that the car builder undoubtedly could have done much better in the choice of his equipment.

When you sell a man an accessory to the extent of touching his pocket book, do not forget that, when you get through, the owner has two things, an accessory and the automobile. You have spent time in explaining the merits of the device. He has taken the time to learn all about it so as to "sell" himself. After he has it, the device is the more important one of the two. In other words, he has an accessory with an automobile attached.

When the piston-ring salesman comes along, the car builder is all wrong. We would hate to check-up the number of different types of piston-ring on the market. Basically speaking, they cannot all be best. If we compared all the claims of the various ring salesmen, he would find many conflicting arguments. The same thing is true of lubricating oils. We have even had oil salesmen come to our factory with microphotos showing the basic difference between paraffin and asphalt-base oils. At the same time this particular oil company was buying its crude oil out of pipe lines into which both paraffin and asphaltum oils were pumped. If you had all the oil salesmen together, you would find also that the arguments flatten out. Undoubtedly you wonder why the car builder does not make specific recommendations as to the oils to use. If this were done, he would need to establish a large department to cover the ground and, after all, what does a sample mean beyond the reputations of recognized brands of oil.

Generalities as to Piracy

Then we come to the parts suppliers, the concerns that manufacture replacement parts, who claim better parts at lower costs than the factory can supply due to the car builder's so-called large over-head or profiteering. Recently, one of our engineers had occasion to visit a spring plant where he was surprised at the large department making car springs for a very popular automobile. After questioning, it was found that these springs were not to be supplied to the car builder but were sold direct to parts suppliers in the field and, further, the springs were made of a much inferior grade of steel to sell at a certain price.

One large car builder spent considerable money road-testing all makes of automobiles and kept a careful record of failures with the object of finding out what were the inherent weaknesses of all automobiles. To his surprise, he noted that car springs stood-out prominently among the failures. Another was electric-light bulbs. Upon checking service records springs were not complained of. Upon checking the field he was astounded at the number of good, bad and indifferent springs supplied by the so-called "gyp suppliers." Electric-light bulbs are the same way; the quicker they burn-out, the more have to be sold to replace them. We have had axle

shafts come into the claim department for credit made of cold-rolled steel; whereas, we use nothing but high-grade heat-treated alloy-steel.

From the foregoing it appears that we are discrediting accessory suppliers but, to the contrary, that is not our intention. What we are trying to bring out is the fact that many salesmen in the field are making an honest effort of selling their wares and, by their sales arguments, are apt to warp the good judgment of the conscientious service mechanic. When one compares the responsibilities of the outside parts or accessory manufacturers with those of the automobile builder, he will see readily who has most at stake. In fact, the latter is directly responsible to the car-owner; whereas, the accessory or outside parts maker is indirectly responsible only. From this one can realize that, when a car builder puts all his efforts and reputation behind his product, he will surround himself with organizations of the highest grade available covering every phase of its construction. This means further that all responsible accessory manufacturers are called in and the particular product adopted which best works out to suit his ideal of design.

Common Sense Is Needed

As expressed before, most automobiles as built today will give good service in the hands of an owner if common sense is applied. Primarily, to do justice when servicing a particular product, every mechanic must convince himself regarding the merit of the product; he must have full faith in the organization behind the product and must faithfully believe in the product. If an employe is in any other frame of mind, he is jeopardizing the product and handicapping his own future. To do himself justice, he should seek employment elsewhere.

A successful field-service organization is one that has the feeling that it is a part of the factory organization in both spirit and at heart. With this attitude of mind, problems always will appear from the simple, rather than from the complex side. Carrying this picture of the responsibility of the service department further, we would like to picture the attitude of mind of the car-owner to be that of a part owner in the respective automobile plant. This spirit of mind can all be accomplished through the service sales-ability of the service department.

Briefly, when an automobile is sold, educate the owner in regard to the many details about the car. Do not wait for him to learn by experience.

In conclusion, we have somewhat side-tracked our anticipated subject, namely, various means of locating trouble. Primarily, because we think it is not possible to outline a major set of rules and, more important, because good faith in the qualities of cars and a proper attitude of mind will enable the difficulties to be located by the most direct route. If we have established that point, our efforts have been well worthwhile.

COOPERATIVE RESEARCH

UNTIL the automobile engineer has intelligently directed and organized all the activities in connection with the discovery and utilization of the forces and materials of nature, we derive little or no benefit from his work. The whole training of an automobile engineer, whose work consists of manufacturing something to be sold, unfits him for the work of research. A moment's thought will show that the mere fact that an engineer has to deal with problems, and dispose of them as they arise, is enough to indicate that his habit of mind is of an entirely different order from that of the man who will patiently carry on an investigation week after week, without ever knowing where it will lead him.

I believe it is the confidence born of the initiative that is a necessary attribute of every engineer which leads him to overlook the facts I have just stated. In reality it is no more possible for him to do his own research work than it is to make the tracings in his drawing office. It is just as needful for him to organize the work of the research men as it is to organize that of the machine-tool operators.

Here, too, we see the importance of capacity for working with other people. In Government laboratories, universities and technical colleges all over the world men are concentrating on the problems that daily confront the automobile engineer. The collecting of information already published, as well as familiarity with what investigators are already pursuing, is more the basis of real research, as it applies to this industry, than the setting forth of particular problems, though naturally the latter appeal more intimately to the practical man, and they may also be of great value suggestively to the investigator. When, however, a concrete problem presents itself for solution, it can and should be submitted to whatever institution is best fitted, by the possession of the necessary personnel, apparatus and authority, to give a final and conclusive report upon it.

If overlapping is to be avoided, such research must be done with the cooperation of all the manufacturers in the industry; first, to insure that the work has not already been done, and, second, to distribute the cost as much as possible. It seems that the great obstacle to this method has been the desire of one individual or firm to become possessed of confidential information that may give him or it some advantage over competitors. The maintenance of secrecy in this respect is in the end impracticable, and the ultimate loss to the industry from lack of cooperation completely outweighs any possible individual advantage that might be obtained through secrecy, and it is happily, coming to be regarded as more advantageous in the end to give away information than by withholding it to forego the acquisition of important knowledge in the possession of someone else.

The final goal to be reached is economy in production, and this is to be attained not only by saving time in factory operations and by employing the most suitable materials, but by taking the fullest advantage of the world's experience to produce only the work that will introduce the fewest number of errors, as these will have to be corrected in the future; and to provide the public with a product low in first cost, long in life, efficient in performance; and, when the time comes, cheap and expeditious to repair. This is my conception of controlling the force and utilizing the materials of nature, and directing and organizing human activities in connection therewith as it applies to the profession of an automobile engineer.—From an address by H. Kerr Thomas, president of the Institution of Automobile Engineers.

Automobile Headlighting Symposium

THE regular monthly meeting of the Metropolitan Section, held at the Hotel Majestic, New York City, on May 21, took the form of a symposium, a large number of speakers entering into the oral discussion of the papers presented by H. M. Crane and J. H. Hunt, while others who were unable to be present submitted written discussions. Some of the latter, because of the valuable information they contain, are included with the two papers of the evening instead of printing them, as is the usual practice, in the discussion. Divergent views expressed on both sides of the question added interest to the meeting.

FUNDAMENTAL PRINCIPLES OF AUTOMOBILE HEADLIGHTING

BY H. M. CRANE[1]

ABSTRACT

AFTER referring to the recommendations made to the National Conference on Street and Highway Safety by the Committee on Motor Vehicles and the Committee's further explanation of the recommendations, the author amplifies more fully the difficulties that have arisen in the operation of the system of headlight regulations sponsored by the Illuminating Engineering Society and this Society and suggests a line of fundamental research with a view to drafting more desirable regulations. Inasmuch as road conditions have changed greatly since the regulations at present in force were first proposed, he believes that a new study of the subject might result in marked improvement.

Definite control of a concentrated headlight beam, deflected below a horizontal line, as originally proposed by the Society, failed to produce the desired result, and the next step was the formulation of the regulations listed in the S.A.E. HANDBOOK.

But these regulations are most effective on a perfectly level road surface and are upset by slight variations in road contour or of car loading; the close adjustments required can be produced only by fairly expensive equipment that is not maintained long in adjustment by the user; enforcement of the regulations is difficult because a head-lamp may get out of adjustment soon after it has been checked. Tilting, as a cure for these difficulties, results only in excessive illumination of the roadway in front of the car and renders the driver almost entirely oblivious to objects beyond.

On narrow crowned roads or on narrow roads with low shoulders, the act of turning out produces a lateral tilting of the car that is sufficient to bring some of the rays within the oncoming driver's vision at close range.

No concrete recommendations are made by the author but further research is suggested to determine the ability of the eye to see under a wide variety of light-distribution. Reference is made to the possible desirability of placing maximum values on supposedly non-glaring beams deflected below the horizontal; of using diffused lighting on vehicles of moderate speed; of mounting lamps asymmetrically; of employing only the right headlight, the left lamp being entirely extinguished and a marker-light being used in its place; of making use of only a single head-lamp mounted on the right side of each car, or a high-power lamp on the right side coupled with a lamp of moderate power throwing a diffused light on the left side, or vice-versa, the left lamp being controlled as to elevation and limited as to candlepower; and of adopting the so-called "courtesy" light.

THE Committee on Motor Vehicles in reporting to the National Conference on Street and Highway Safety made the following recommendations regarding automobile headlights: (*a*) present lighting regulations should be more rigidly enforced as a necessary beginning in arriving at any improved night-driving condition on the highways and (*b*) the study of proper road illumination, combined with the minimizing of undesirable glare, should be given immediate further consideration with a view to determining whether it may not be possible to improve the regulations now in force. In explaining these recommendations, the Committee made the following brief analysis of the existing situation, which was printed in the latter part of the report.[2]

> The question of proper road illumination for night-driving has been a subject of attention for the last 25 years, due to the conflicting requirements of the driver behind the headlight and the driver meeting the headlight. It might be well to give an outline of the history of headlight regulation to clarify the Committee's recommendation.
>
> The first headlights of any real power on motor cars were of the acetylene type, and when first used were criticized very severely as producing glare. This was due to the fact that most other vehicles had either no lights at all or else very ineffective oil-lamps. When the electric headlight was introduced as part of our automotive equipment, a time came when the number of motor cars was increasing with extreme rapidity and the combination created a very unsatisfactory condition. This was partly due to the early design of the electric headlight in which the most piercing beam possible was produced by the aid of a high-power bulb in connection with a parabolic reflector. Conditions rapidly became intolerable with the large number of electrically lighted cars and various types of regulation were undertaken. In the early regulation the question of glare was treated as being of paramount importance and practically nothing was done to ensure that a safe driving-light should also be obtained. As a result, the Illuminating Engineering Society and the Society of Automotive Engineers took up the subject in a very serious manner, with the result that a certain form of light distribution was worked out as being the best compromise between absence of glare and the presence of sufficient light for safe driving. This light distribution is obtained by the use of either special mirrors or lenses, or both, in connection with very definite adjustment of the headlights themselves. These requirements have been put into force in a very considerable number of states during the last few years, either by

[1] M.S.A.E.—Technical assistant to the president, General Motors Corporation, New York City.

[2] See Report of the Committee on Motor Vehicles, National Conference on Street and Highway Safety, p. 14.

legislation or regulation. It is fair to say, however, that only one or two states have made a serious effort to enforce the regulations as laid down. It is more and more apparent as time goes on that we have not yet reached an ideal solution of the problem. In the first place, the recommended light-distribution is worked out on the basis of two vehicles approaching on a level road and without any considerable amount of spring action. This is due to the necessity of keeping the piercing part of the light-beam as high as possible without actually shining in the eyes of the driver of an approaching vehicle. The desired condition is badly upset on roads of a rough contour or even on roads of a rough variety that may cause a vehicle to pitch upon its springs. The accurate working-out of the desired light-distribution requires a better lamp-equipment than has been commercially furnished uptodate and a certain degree of care and attention on the part of the owner. To date, the lamp equipment on the cheaper cars cannot be expected to fulfil permanently the requirements of this type of regulation.

It is recognized by the Committee that regulation of the headlight is a very difficult problem, due not only to the conflicting requirements as outlined above but also to the wide range of conditions under which motor cars are operated. The regulations described above have been made legal in a very considerable number of states but so far have been enforced in only a few of these states. Until complete enforcement over a period of time occurs, it will be impossible to judge correctly the final desirability of these regulations.

The object of this paper is to explain rather more fully the difficulties that have arisen in the operation of the system of headlight regulations sponsored by the illuminating Engineering Society and the Society of Automotive Engineers, and to suggest a possible line of fundamental research intended to allow the drafting of more desirable regulations, if this be possible. It does not seem to me to be a serious criticism of the work already done to suggest that the subject be reopened now. The road conditions in this Country have changed greatly since these regulations were first proposed and motor-car traffic has changed to an even greater extent. When we add to these facts the knowledge gained by the equipping and use of several million automobiles in accordance with the regulations referred to, we have every right to expect that a new study of the subject may result in a marked improvement.

Origin and Limitations of Regulations

The first really serious objection to headlight glare came as the result of electric lighting and largely because advantage was taken by the car builders and the lamp makers working together of the possibility of an extremely powerful beam of light in a highly concentrated form. Compact filaments sharply focused in parabolic reflectors came into general use and did not fail to produce violent complaints from drivers of approaching cars. New Jersey was one of the first States, if not the very first, to attack the problem of headlight glare by accepting certain devices for use, based on the personal examination of the controlling officer. I do not think that any scientific rules or mathematical measurements were involved at that time. In spite of this fact, or possibly because of it, the New Jersey regulation of that time was about as satisfactory, in my opinion, as is the present regulation.

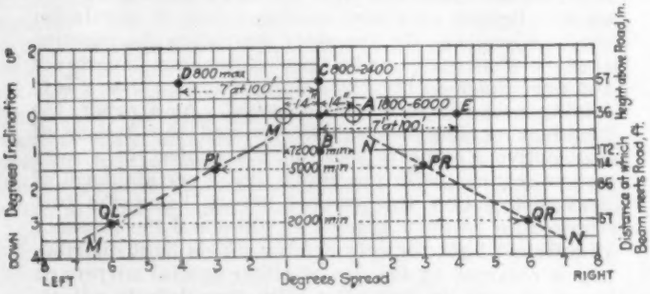


Fig. 1—Diagram of Test Positions

This Figure Is Reproduced from the S.A.E. Handbook. All Points on the Curves MM and NN Are 6 Ft. from a Line Midway Between and Parallel To the Axes of the Lamps at the Point Where the Beam Meets the Road

Control of Concentrated Beam

One of the earliest solutions proposed in this Society was based on the definite control of a concentrated headlight beam, the idea being to use a concentrated beam but to require its deflection below a horizontal line sufficiently to prevent its reaching the eyes of the driver of an approaching car. This was probably the worst possible form of regulation, for it resulted in excessive illumination of a very small area in the driver's field of vision and, to all intents and purposes, no illumination of the remainder. Headlights of this type could be very blinding if not dimmed, on roads having a rolling contour.

I joined the Lighting Division of the Standards Committee at the time that this type of regulation was still in the S.A.E. Handbook and found that the deficiencies were well recognized and that, in collaboration with the Illuminating Engineering Society, an attempt was to be made not only to keep headlight glare under control but also to provide a complete driving-light. As a result of this work, the regulations listed on p. B7 and subsequent pages of the S.A.E. Handbook were drawn up. The gist of those regulations is usually shown on a chart, as published on p. B8 of the S.A.E. Handbook, which is reproduced in Fig. 1. These regulations have been put into force in a considerable number of states. A serious attempt at rigid enforcement has been under way in Massachusetts for about 2 years and has recently been begun in New York.

Effect of Variations of Road Contour

I do not believe that any engineer will claim that this type of regulation has proved to be thoroughly satisfactory. In the first place, it is a system of control that can be expected to be effective only on a perfectly level road surface. I will show a little later, by charts, how slight the variations in road contour or car loading need be to upset completely the desired light-control. A study of the charts will indicate also how close the adjustment of headlights and accessories must be to obtain the desired result, an adjustment that can be readily produced only by fairly expensive equipment that we know by experience is never maintained long in the hands of the user. I would be the last one to deprecate the cost of necessary equipment if this type of headlighting regulation really produced a thoroughly satisfactory condition when in adjustment; but because, for the reasons given above, it has serious deficiencies even when perfectly applied, I am convinced that we ought to make a determined effort to obtain something better. Another, and possibly the most serious, objection to the present form of regulation, is the difficulty of practical enforcement. It is none too easy to check up on all the multitude of automobiles in service and to require them to have their headlights adjusted, for we know that any headlamp may get out of adjustment again the day after it has been checked, because of mechanical changes in the equipment, the burning-out and replacing of a bulb, or some change in the loading of the vehicle.

It may be said that a further tilting of the headlights would be a cure for most of the difficulties mentioned. I contend that this is not the case, because increased tilting of headlights will result in excessive illumination of the roadway directly in front of the car, and because, as the driver's eyes become accustomed to this illumination, he will be almost entirely oblivious to objects beyond in any direction. I shall refer to this point later, for I think it is one upon which research is essential at this time.

Illumination at Point B

In discussing the present type of regulation, I shall call attention primarily to point *B* on the diagram. Point *B* is the projection of a line 1 deg. below the horizontal;

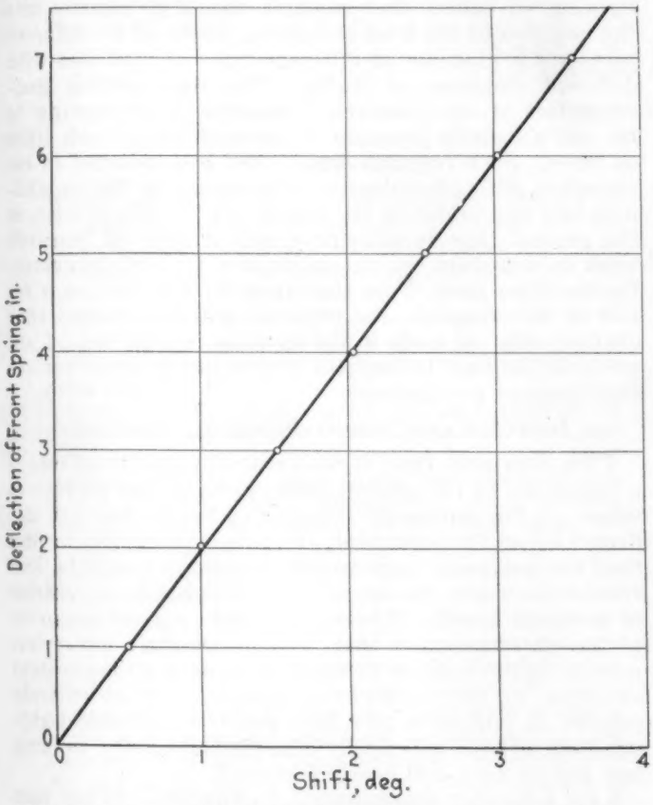


Fig. 2—Shifting of Headlight Beam-Angle with Deflection of the Front Springs
In a Car Having a Wheelbase of 113 In., a Deflection of 2 In. Corresponds Almost Exactly to a Shift of 1 Deg. in the Headlight Beam

at this point the minimum of 7200 cp. is required, but many lamp companies claim several times this candlepower. I shall first call your attention to the two curves. Fig. 2 shows how the headlight beam-angle shifts as the front springs of a car of 113-in. wheelbase deflect. You will notice that a deflection of 2 in. corresponds almost exactly to a shift of 1 deg. in the headlight beam. I have taken a wheelbase of 113 in. because many cars having this wheelbase are in use, and many more have less. This refers to the motion of either the front springs or the rear springs alone. The same result, of course, will be produced by an equivalent change of level because of a change in the contour of the surface of the road. It is obvious from this curve that a change of level of 5 in. in the length of the car, whether produced by rocking on the springs or by variations of the road surface, can readily direct the most piercing part of the headlight beam into the eyes of an oncoming driver.

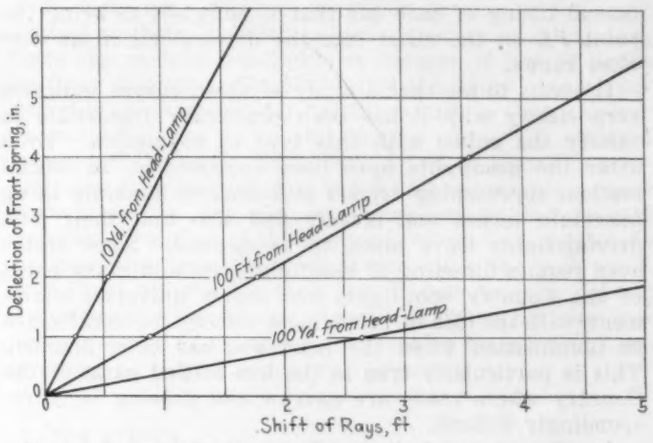


Fig. 3—Another Way of Presenting the Same Information
The Curve Shows the Rise and Fall of the Headlight Beam of the Car Previously Described, First, at a Distance of 100 Ft. and, Second, at 300 Ft. from the Headlight

Fig. 3 is another way of presenting the same information. This curve shows the rise and fall of the headlight beam of the car previously described, first, at a distance of 100 ft. and, second, at 300 ft. from the headlight. It is obvious from this curve that comparatively slight irregularities of road surface or of spring motion can bring a blinding beam into the eyes of an approaching driver at a distance of 100 yd.; also, note that it takes less than 7.0 sec. for a car running at 30 m.p.h. to traverse 100 yd. and less than 3.5 sec. for two cars each running at this speed to meet from this distance.

Fig. 4 shows the distance at which a driver may receive a blinding ray when two cars are approaching at the crest of a hill. On grades of from 7 to 10 per cent, two cars may be only a very small distance apart when this condition occurs. Of course, the diagram indicates an attempt at lateral control of the headlight beam, but this is even more difficult to handle properly than is vertical control, and is considerably more upset by road curvature or traffic conditions.

Effect of Narrow Crowned Roads

A further unfortunate condition arises on narrow crowned roads or narrow roads with low shoulders, on which the very act of turning out to pass results in a

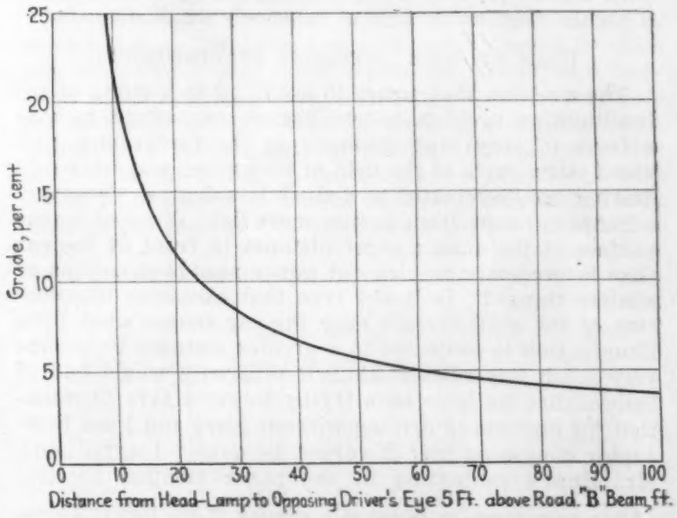


Fig. 4—Distance at Which a Driver May Receive a Blinding Ray When Two Cars Are Approaching at the Crest of a Hill
On Grades of from 7 to 10 Per Cent the Cars May Be Only a Very Small Distance Apart When This Condition Occurs

lateral tilting of each car that is sufficient to bring the point *PL* on the chart into the drivers' vision at very close range.

It seems to me that a study of these curves indicates very clearly why it has been practically impossible to satisfy the public with this type of regulation. Even after the headlights have been approved at an official station, approaching drivers still demand dimming in no uncertain terms, and drivers find also that their own driving-lights leave much to be desired. Some states even require dimming of headlights, while in many parts of the Country spot-lights are nearly universal equipment, with the idea of providing a remedy for deficiencies in illumination when the headlight has been dimmed. This is particularly true in the less settled parts of the Country where roads are narrow and passing is correspondingly difficult.

Another phase of the headlight situation that has not been sufficiently studied is the condition that exists on Sundays and holidays after dark in outlying districts having no general road-illumination. It seems hardly worthwhile to go into greater detail concerning facts that are so well recognized. I will, therefore, proceed to the much more difficult question, What can be done to improve existing conditions?

Further Research Needed

I will say frankly at the outset that I have no concrete proposal to make as to apparatus or equipment that will produce a marked improvement.[3] I am convinced, however, that such apparatus can be designed and produced, but only after some fundamental research has been made on the various factors involved in effecting a successful compromise. The factor that I consider of greatest importance is the action of the human eye, very remarkable mechanism that can accommodate itself to a variety of conditions of vision, both as to focus and to degree of illumination. Unfortunately, the rate of accommodation is far from instantaneous. The eye adjusts itself to illumination by varying the diameter of the pupil and this diameter is controlled to a large extent by the most brilliantly illuminated part of the field of vision. Keep in mind that the eye has a relatively narrow angle of vision that still makes possible a wide range of vision on account of the mobility of the eyeball. This narrow field of vision makes blinding possible from a highly illuminated field of relatively small diameter.

Beam of High Intensity in Foreground

The question that comes to my mind in a study of the headlighting problem is whether we can afford to have a beam of very high intensity in the foreground, provided other parts of the field of vision necessary for safe driving are illuminated to a much less degree. Does any advantage result from having more light directed on the surface of the road a short distance in front of the car than is necessary to pick out minor road-obstructions or similar things? Is it not true that excessive illumination of the road surface near the car causes what little illumination is projected to a greater distance to become very much less efficient than it otherwise would be? I believe that we have been trying to get a safe illumination for high-speed driving without glare and I am thoroughly convinced that it cannot be done. I agree with Mr. Hunt's contention in the paper entitled Electric Lighting Equipment on Automobiles[4] that he presented at the 1925 Spring Convention of the American Institute of Electrical Engineers in St. Louis that drivers who believe that they have good high-speed illumination with equipment designed according to present regulations are actually driving with the lamps tilted up in a way that would not pass inspection.

As to research, I am strongly in favor of making a most thorough study of ability to see under a wide variety of light distribution. I do not believe that we can depend on the judgment of a man driving behind a pair of headlights whether they produce a good driving light. The average driver is prone to judge the efficiency of the lights from the brightest part of the field of illumination and not from the all-round completeness of the lighting. I believe that research should go equally into the question of the kind of lighting required in different parts of the Country on different types of road and with different densities of traffic. The Headlighting Subcommittee of the Research Committee is attempting to lay out a definite program of research along such lines as these. Such research should first be conducted in cooperation with physiologists with regard to the capabilities and limitations of the human eye. I do not wish at the present time to anticipate such a piece of research work by definitely recommending any type of apparatus. On the other hand, I am absolutely certain that, as a result of this research, the majority will be satisfied that changes must be made in the lighting regulations. I am perfectly willing to suggest points at which I believe that changes are desirable.

Diffused and Non-Symmetrical Lighting

I am convinced that, if we eventually decide to retain a regulation of the present form, we must put maximum values on the supposedly non-glaring beams that are deflected below the horizontal. I am fully prepared to find that the maximum permissible illumination will be low enough to justify the use of diffused lighting on vehicles of moderate speed. This would include a great majority of the passenger cars that, because of their low price, inferior equipment and deficient up-keep, are the greatest offenders in the headlighting problem. It is entirely possible to produce a very fair quality of diffused lighting that will be practically non-glaring, cheap in first cost and up-keep, and nearly foolproof.

I see a further possibility of improvement in the fact that regulations now in force are based on twin headlights symmetrically mounted. I can see no reason that a symmetrical mounting is necessarily desirable except for reasons of appearance. The use of spot-lights and so-called "courtesy" lights unsymmetrically mounted, even in the crude manner in which these devices have been tried, indicates strong possibilities in favor of asymmetrical illumination.

I wish also to make a suggestion regarding congested traffic, namely, the possibility of using only the right headlight, the left lamp being entirely extinguished and a marker-light on the left side used in its place. I might even suggest the possibility of using only a single headlamp mounted on the right side of each car, or the use of such a lamp of high power on the right side coupled with a lamp of moderate power throwing a diffused light on the left side. Another possible arrangement is a left headlight of high power and a right diffused headlight, the left beam being uncontrolled as to elevation but having a certain maximum candlepower, and being used with the proviso that it must be dimmed or extinguished on the approach of another car.

[3] In a later paper, presented at a meeting of the Detroit Section of the Society, Mr. Crane made specific suggestions of different forms of equipment. See p. 535 of this issue of The Journal.

[4] See *Journal of the American Institute of Electrical Engineers*, May, 1925, p. 476.

The Courtesy Light

In addition to these suggestions, J. H. Hunt has proposed a thorough study of the possibilities of the so-called "courtesy" light, the idea being that the use of such a light in conjunction with dimmed headlights would be a material improvement over the present standard system.

I believe that I have given ample reasons for reopening the headlighting question. I am equally certain that with the united engineering ability of those interested in this subject, including motor-car builders, dealers in lighting equipment, enforcement authorities and users, we can make a much needed improvement that may then become the basis of nation-wide regulation.

In conclusion, I will say that I have never sympathized with those who attribute accidents to cars under their control to their inability to see, either because of glare from approaching headlights or because of lack of lights on their own cars. Dr. Dickinson[5] has enunciated a very valuable principle of safe driving, which is that a driver is responsible for being able to stop within the distance over which he has a clear view. I believe that this principle was originally applied to vehicles approaching street corners, but in any case it applies equally well to cars passing at night. This does not, of course, absolve us as engineers from the duty of providing the best available light for the car-user, but it does leave a definite responsibility for giving a useful light and not simply a very powerful illumination that creates an erroneous impression as to wha[t] can really be seen.

HEADLIGHTS

BY J. H. HUNT[6]

ABSTRACT

TWO points are cited as illustrating the difficulty of enforcing the present regulations, namely, (*a*) the variation in the angle of the headlight beam caused by the compression of the springs when the loading of the car is changed from no load to full load and (*b*) the variation of the tilting of the beam caused by the pitching of the car on an ordinary road, the effect being similar to that produced by flashes of lightning in a pitch-dark night.

Denial is made of the author's alleged advocacy of diffused lighting and comparison is made of the distribution-curves obtained with frosted bulbs and those obtained with fairly good lamps conforming to the Society's specifications. Attention is called to three points in this comparison: (*a*) the light from the frosted bulb along the horizontal is only about 50 per cent of that available with a lamp conforming to the Society's specification (*b*) the foot-candle illumination measured perpendicularly to the beam at various points on the surface of a level road is much less with the frosted bulb than with the lamp of the Society's specification, how much harm a bright illumination immediately in front of the car interferes with acuity of vision is a subject for additional research and (*c*) the light from the frosted bulb does not change appreciably for any angle through which the chassis is likely to move as a result of road shocks; consequently, when the frosted bulb is used, road shocks and spring vibration do not affect the eyes of an approaching driver.

Sharp cut-off above the horizontal is considered inadvisable. The possibilities of non-symmetrical lighting, the author believes, are worth considering, and the results of some experiments are detailed. He expresses a preference for the use of two diffused lights as regular equipment and of a third lamp, adjusted according to the Society's specifications, so that the maximum candlepower would be horizontal.

Reference is made to the test target in use by the Royal Automobile Club and to the results of tests made with it, but this method is said to be objectionable as a basis of specifications because it is tedious and the results depend largely upon the condition of the observer's eyes.

Although measurements of all the imaginable functions of the human eye have apparently been made, such tests should be repeated under automobile-lighting conditions, for factors that previously may have been neglected in tests frequently become important when the conditions are changed. As the normal eye requires nearly 1 sec. to adjust itself to radically changed conditions of illumination, this period is dangerously long when a car is running at high speed.

TWO points deserve emphasis with relation to the difficulty of enforcing our present specifications. In Table 1 is shown the change in chassis-angle, which also means a change in the headlight beam, as the load in the car is varied. This includes some data taken on a few cars that were immediately available. The table shows the wheelbase and the car-weight, which give some measure of the strength of the springs and their proper reaction to change of load. We took a reading of the chassis-angle with only a 145-lb. driver in the car, then filled the remaining seats; thus, if we had a four-passenger car, three other persons were added; if a five-passenger car, four were added.

We tabulated the total weights of the cars and the changes in the chassis-angle. For a very heavy coupe with a long wheelbase, we have only a 10-min. change, while on a short-wheelbase phaeton we have a 1-deg. change in one case, 50 min. in another, and 1 deg. 5 min. in a third. We have a 30-min. change in a cyclecar that carries a passenger who is seated beside the driver, both being located at the center.

We have been informed by R. N. Falge and C. A. Michel that an extensive series of data collected by them and involving a very much larger number of cars indicates that the limited data before us give an understanding of the situation. Thus, inherent in the lighter cars, which form the majority of the cars on the road, is a shift of about 1 deg. in the direction of the beam with a change of load from that of the driver only to full load. This means that, if the lamps are adjusted according to

TABLE 1—CHANGE OF CHASSIS ANGLE WITH LOAD

Type of Car	Wheelbase, In.	Weight of Empty Car, Lb.	Weight of Driver, Lb.	Total Number of Passengers	Loaded Passenger Weight, Lb. Front	Loaded Passenger Weight, Lb. Rear	Change of Angle, Deg.—Min.
Sedan	120	4,200	145	5	315	465	0—55
Coach	112	2,675	145	5	315	465	0—50
Coach	108½	2,850	145	5	315	465	0—45
Coupe	132	3,955	145	4	315	310	0—10
Phaeton	103	1,890	145	5	315	465	1— 0
Phaeton	112½	2,745	145	5	315	465	0—50
Coupe	115	2,810	145	4	315	310	0—35
Phaeton	110	2,300	145	5	315	465	1— 5
Phaeton	120	3,625	145	5	315	465	0—45
Phaeton	128	4,500	145	5	315	465	0—30
Phaeton	113	2,610	145	5	315	465	0—55
Phaeton	100	1,760	145	5	315	465	0—50
Cyclecar	75	1,000	145	3	315	145	0—30

[5] See THE JOURNAL, July, 1925, p. 81.

[6] M.S.A.E.—Head of the electrical division, General Motors Research Corporation, Dayton, Ohio.

the Society's specifications for full load, the lamps will be tilted down 1 deg. below the value shown on the chart in the S.A.E. HANDBOOK when the driver is alone. This throws the main intensity of the beam on the road much too close to the car. In my opinion, such lamps are hardly safe for our legal speed-limit of 35 m.p.h. under some road conditions.

LAMPS SET TOO HIGH

When I began to check my own lamps, I found that I had always been driving with the lamps set at too high an angle, for I had usually adjusted the lamps with the car empty. I am inclined to think most owners do this. With a full load, the lamps are tilted up about 1 deg., which is fine for one's own eyes but very unsatisfactory to drivers of approaching cars.

The other point also has to do with the tilt. Fig. 1 shows that we have a very high candlepower at a point between 1 and 2 deg. below the horizontal for the standard car. Mr. Crane has already pointed out the effect of spring deflection and that a 2-in. deflection of either the front or the rear springs means 1 deg. of tilt in a car having a 113-in. wheelbase.

Those of us who have ever lived in the country remember how well one can get about on a pitch-dark night, if lightning is occurring fairly frequently. We feel that we have good lighting with the present specifications of the Society but we are really driving on an equivalent effect. The pitching of the car on an ordinary road, even if the head-lamps are properly pointed for the load then in the car, results in flashes of light 1 or 2 deg. above the normal angle, which give a view of the road that would otherwise not be available, but also throw the light in and out of the eyes of a driver who is approaching. I will admit that it is not so bad for a person receiving it to have this light flash into and out of his eye 20 per cent of the time as it would be if the light were perfectly steady. It is sufficiently disturbing, however, as it is.

LAMPS TILTED ANY DESIRED DEGREE

We have recently tried the experiment of arranging a set of lamps so that they can be tilted to any desired degree. We have driven toward these lamps while a man worked the lever and rocked the lamps in any desired manner. I recommend that those of you who have an opportunity should try such an experiment. The lamps give the impression of being installed on a gigantic pendulum that is swinging back and forth. It is difficult enough to estimate the distance of approaching cars under night-driving conditions without having a complication such as that just described.

FROSTED BULBS

Diffused lighting has already been referred to. I seem to find myself in the position of advocating the installation of frosted bulbs in the present equipment. I object to being placed in this position. I am simply advocating that they should receive careful consideration and am inclined to put more emphasis on this consideration than I should otherwise, because my original attitude toward this proposal is exactly the same as that of many persons who are most outspoken against it. When the suggestion was first made to me, I maintained that it could not be followed successfully. I secured some 21-cp. standard bulbs and frosted them, trying different degrees of frosting. The result was that the distribution intended by the use of the lens and the reflector was ruined without having proper compensation in the distributed light. Later, I obtained some 32-cp. 2-in. heavily frosted bulbs and secured results from them that were different from those of the experiments mentioned.

Fig. 5 gives a distribution-curve of a 2-in. frosted bulb in comparison with the distribution of light from a fairly good lamp conforming to the Society's specifications. We are indebted to Mr. Falge for this information. I wish to call your attention to three things in connection with this chart. The first is that, along the horizontal, the light from the frosted bulb is about 50 per cent of the light that is available with a lamp conforming to the Society's specification. This does not mean, however, that the visibility of objects on the level with the lamps is reduced 50 per cent. Fortunately, the eye does not work in such a way that a direct relation exists between the physical quantity of illumination and the physiological result of visibility. The relation is

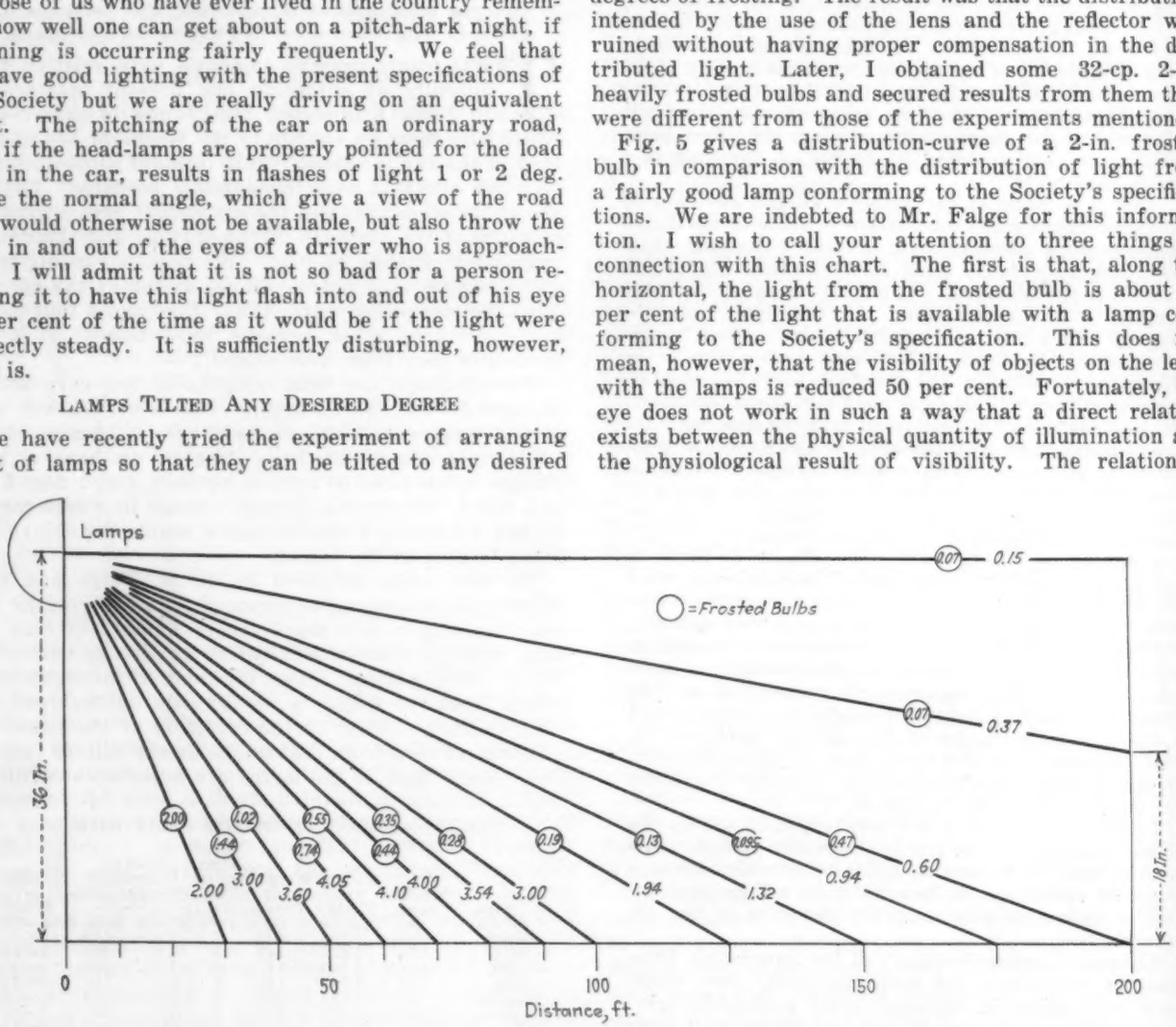


FIG. 5—LIGHT-DISTRIBUTION CURVES OF A 2-IN. FROSTED BULB AND A FAIRLY GOOD LAMP CONFORMING TO THE SOCIETY'S SPECIFICATIONS

Three Points To Be Noted Are (*a*) the Frosted Bulb Gives Only About One-Half the Horizontal Illumination of the Other Lamp; (*b*) the Illumination of the Roadway at Points Perpendicular to the Beam Is Very Much Less and (*c*) the Light from the Frosted Bulb Does Not Change Appreciably Because of a Change of Angle through Which the Chassis May Move as a Result of Road Shocks

logarithmic. This means that one's ability to see an object on the level of the lamps with only 50 per cent as much illumination is really only slightly reduced, instead of being cut in half, assuming that no other complicating factors are present.

Illumination Between Car and Object

Another factor, however, that complicates the situation is the difference in the illumination on the roadway between the car and the object that is being viewed at lamp level. Fig. 6 shows the foot-candle illumination measured perpendicularly to the beam at various points of the surface of a level road for the lamp conforming to the Society's specification and for the frosted bulb. As you will see, very much more illumination on the roadway results from the lamps of the Society's specification than from diffused lighting. Any light on the road in excess of the amount needed to make obstructions visible immediately in front has a tendency to reduce the sensitivity of the eye when viewing objects in a weaker field of illumination. How much harm a bright illumination immediately in front of the car does to one looking at a distant object is a matter of research that will require considerable additional investigation. I shall not say that it seriously interferes but undoubtedly it does reduce, to a certain extent, the acuity of one's vision.

The third important fact is that the light emitted from the frosted-bulb lamp does not change appreciably because of a change of angle through which the chassis may move as a result of road shocks. Consequently, road shocks and spring vibration do not affect the light reaching the eyes of an approaching driver.

Sharp Cut-Off Above Horizontal

I have had an opportunity to drive behind practically all the lamps that are on the market in this Country, and also a large number of lamps that have been secured from abroad. Although I do not wish to make many general statements, I feel safe in making one statement regarding lamps that completely cut-off the light above the horizontal. I had an opportunity to drive with some lamps that accomplished this result very completely. In addition to feeling very uncomfortable, while driving with them, I nearly had a tragic accident. Only a pair of white socks on the feet of a pedestrian on the road saved him from being struck by a 4200-lb. car. At the time this happened, I was meeting another car that may have interfered somewhat with my vision; but I have repeatedly had the experience of almost striking obstructions that might easily have been seen had some light above the horizontal been available.

Non-Symmetrical Lighting

As Mr. Crane has mentioned, non-symmetrical lighting has possibilities that are worth considering. Several years ago, W. A. Chryst equipped a car that gave interesting results. The glass on the right lamp was frosted, while that on the left lamp was clear. This was before the days of deflecting lenses. Both lamps were equipped with a smaller bulb for parking-lamps. A separate switch on each head-lamp was so arranged that it could easily be switched from the large bulb to the parking-bulb on the left lamp, leaving full candlepower back of the frosted glass and giving a diffused light to mark the side of the road. Results apparently were very satisfactory. Later, I copied the same experiment on my own car by mounting one of the first deflecting lenses to be placed on the market in the right lamp, pointing it down rather more than was required by the Society's specifications, and using the same combination for the left lamp that has been mentioned above. I found it to

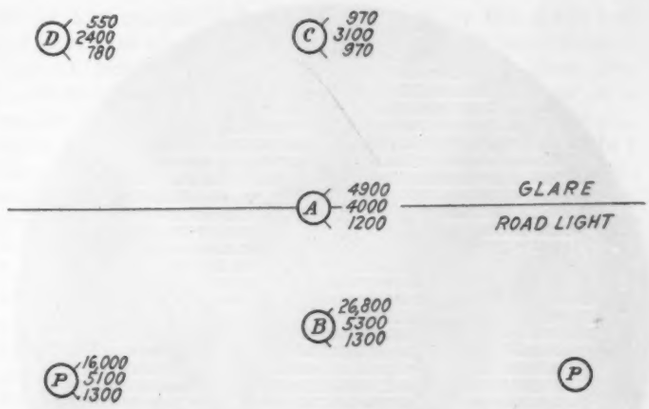


Fig. 6—Road Illumination Obtained with Different Types of Head-Lamp
These Results, Which Are in Foot-Candles, Were Measured Perpendicularly to the Beam at Various Points of the Surface of a Level Road

be a very satisfactory driving-lamp and, so far as I could judge, approaching drivers were equally well satisfied. I used this combination for several years and abandoned it only after the law requiring deflecting lenses had been put into effect in Ohio.

If I were to state my preference, without considering the other driver, I should use two of these diffused lights as regular head-lamps, and place a third lamp, adjusted to the Society's specifications, so that the maximum candlepower would be horizontal. I should be perfectly willing to dim the bright lamp, or to cut it out completely, at the time of meeting another car. This would give a wonderful result, so far as the man behind the lamps is concerned.

Frosted Bulbs

When two frosted 32-cp. lamps are used, giving a light distribution such as that shown by the chart in Fig. 7, much more light will appear at the *C* and *D* points than is permitted in the Society's specification. As a matter of experiment, however, I have found it possible, when behind a pair of these lamps, to meet a car similarly equipped on a narrow road and pass it with less discomfort than when meeting lamps conforming to the Society's specification. This is probably due to the fact that the widely diffused light from the frosted bulbs on the lamps of the other car illuminates the sides of the road immediately in front of the approaching car in such a way that a much better opportunity is afforded to judge clearance than when the approaching car has lamps of the type called for by the Society's specification.

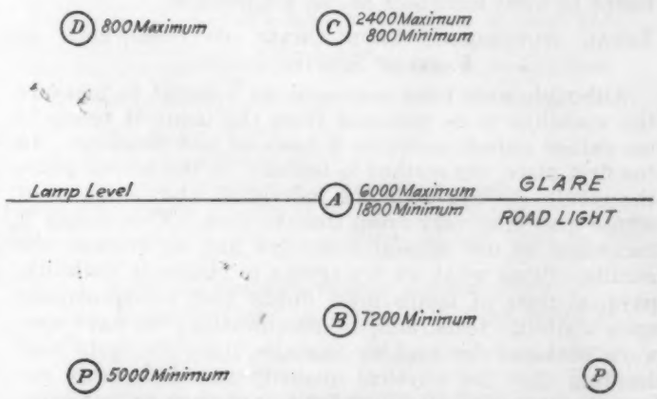


Fig. 7—Illumination with Two Frosted 32-Cp. Bulbs
With Such a Distribution of Light More Light Will Appear at the *C* and *D* Points than Is Permitted in the Society's Specifications

FIG. 8—ROYAL AUTOMOBILE CLUB TEST-TARGET CHART
The Test Consists of Determining the Distances at Which the Disc May Be Detected When Placed in Various Positions

The above-mentioned tests were made when the windshields were clean and dry. Considerably more experimentation is necessary, of course, before one can say whether the results would give a desirable all-round illumination.

BASIS OF BRITISH SPECIFICATIONS

The Society's specification is based on physical tests, with the idea that it should be possible for a manufacturer to send lamps to electrical testing laboratories and find out quickly whether the lamps meet the specification, since the physical tests require only a comparatively short time. That method of drawing up a set of specifications is probably the only satisfactory way of applying them. Another way, however, is to base the specification on the visibility obtained from the lamps, as is done in England.

Fig. 8 shows the Royal Automobile Club test-target chart. The testing of a set of lamps consists of determining the distance at which the disc may be detected in various positions. In testing for glare, the disc is placed behind and to one side of the lamps under observation, as is shown on the chart. The observer then walks toward the lamps and determines how close to the lamps he must be before he can see the disc.

ROYAL AUTOMOBILE CLUB CHART OBJECTIONABLE AS BASIS OF SPECIFICATIONS

Although such tests represent an attempt to measure the visibility to be obtained from the lamp, it seems to me rather objectionable as a basis of specifications. In the first place, the method is tedious; in the second place, the results depend upon the individual, the condition of whose eyes may vary from time to time. This makes it necessary to use several observers and to average the results. Since what we are trying to obtain is visibility, physical tests of lamps must finally rest fundamentally upon visibility tests, and the specifications we have now were obtained by making certain visibility tests and deciding that the physical quantity specified would secure the necessary visibility for an ordinary pair of eyes.

[1] For bibliography, see THE JOURNAL, August, 1925, p. 156.

The reason for bringing the Royal Automobile Club method of testing to your attention is to emphasize the fact that our specifications are finally based on visibility tests, and also to suggest that, if any changes are to be made in the specifications, they should be made on the basis of repeating or extending the visibility tests. So far as the Royal Automobile Club target is concerned, considerable can be said both for and against such a test object. It does not stand out strongly enough from the landscape, especially when it is viewed over a dark roadway. But it does give a basis of testing from which considerable experience has been developed.

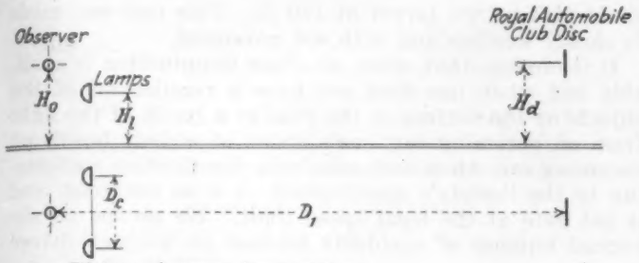
Mr. Crane advocates that we should go back to visibility tests with the various types of lamp that have been suggested and should determine the all-round results. It is conceded, of course, that the original committee did exactly this thing; but we have had considerable experience with automobile lighting in the last 5 years and it is possible that additional work might be done profitably.

THE HUMAN EYE

Your attention has been called to the fact that the eye is a very wonderful instrument but has certain limitations. I have attempted to go over some of the literature that has appeared on this subject.[1] The indications are, however, that apparently all the types of measurement of the functions of the eye that can be imagined have already been taken. Practically no tests, however, have been carried out under conditions that approximate as closely as would be desirable those existing in automobile lighting. It seems to me that it would aid in our own education to have some of these tests repeated under automobile-lighting conditions.

Thus, tests that have been made of the recovery of the eye from glare, under the conditions that control the illumination of a store window, for instance, undoubtedly contain all the physical, psychological and physiological effects that occur in connection with automobile lighting. It would, however, be very much easier to explain our findings if we repeat these tests under automobile conditions than if we attempt to decide our case without new data. Furthermore, in tests involving as many complicated factors as are involved in a question like this, the possibility always exists that due weight has not been given to all the factors. So many things must be observed, so many readings taken that, in making tests, one usually protects one's self by eliminating the minor factors, using one's judgment and deciding that it is not necessary to keep a record of this or that factor. These neglected factors frequently become very important under changed conditions.

Mention has been made of the fact that the eye adjusts itself by the contraction of the pupil. This adjustment covers a range of only about 16 to 1; that is, investigations show that the change in area covers such a ratio. As a matter of fact, however, the eye can cover the range from just barely seeing to blinding glare, which is a ratio of illumination of about 10,000,000,000 to 1. The range of illumination from driving in daylight to driving at night, with the present illumination, involves a ratio of between 10,000 and 100,000 to 1. This normal range of sensitivity is accomplished by changes in the chemical action that takes place inside the eye. The change in sensitivity due to chemical action, however, seems to take about the same time for readjustment that the area of the pupil itself does after an abrupt change in conditions has occurred. Thus, in the normal eye, a period of nearly 1 sec. elapses after the time of



D_c = Distance between lamp centers
D_1 = Distance disc is visible when observer is directly back of lights
H_d = Height of disc center
H_l = Height of lamp centers
H_o = Height of observer's eyes

FIG. 9—RESULTS OF FIRST TEST TO DETERMINE THE VISIBILITY OF THE ROYAL AUTOMOBILE CLUB CHARTS

The Disc Was Illuminated only by the Lamps. The Pavement was of Brick and the Night was Clear

TABLE 2—VISIBILITY OF DISC ALONE WITH DIFFERENT KINDS OF LIGHTS

Plain Parabolic Reflectors; Standard Bulbs; Beam Not Tilted

$H_o = 5.5$ ft.	$H_l = 39$ in.	$D_c = 28.5$ in.
$H_d = 2$ ft.	$H_d = 4$ ft.	$H_d = 6$ ft.
$D_1 > 500$ ft.	$D_1 > 500$ ft.	$D_1 > 500$ ft.

Plain Parabolic Reflectors; 32-Cp. Frosted Bulbs

$H_d = 2$ ft.	$H_d = 4$ ft.	$H_d = 6$ ft.
$D_1 = 285$ ft.	$D_1 = 318$ ft.	$D_1 = 345$ ft.

No. 1 Lamps Adjusted to Society's Specification as Closely as Possible

$H_d = 2$ ft.
$D_1 = 425$ ft.

No. 1 Lamps; Beams Tilted

$H_d = 2$ ft.
$D_1 = 153$ ft.

Disc was not illuminated by any source except observer's lights

Test was made on a clear night; roadway consisted of brick pavement

A railway embankment was back of position *B*

radically changing the illumination conditions before a reasonable percentage of complete readjustment takes place. If the eye is really blinded by a glare that has existed long enough to make the eye adjust itself to it, nearly 1 sec. will be required before the eye will return to a condition of good vision under feeble illumination. One second is a dangerously long time when a car is running at high speed.

NEED OF FURTHER STUDY

The question of repeating some of the illumination investigations under automobile conditions is of sufficient importance to the industry to justify going over the data again and repeating such tests as may be necessary. We should be entirely sure that we cannot do better than we are now doing before we cease trying.

This statement should not be taken as a criticism of the work that has already been done. It has been pointed out at a Research Committee meeting that the present specifications have been revised two or three times since they were originally issued. Possibly all that we need to do is add one or two more limits to these specifications. As an example, following Mr. Crane's suggestion, we might very well put maximum limits on the amount of light below the *B* point, which certainly does not reach down the road and undoubtedly reduces our ability to see at a distance.

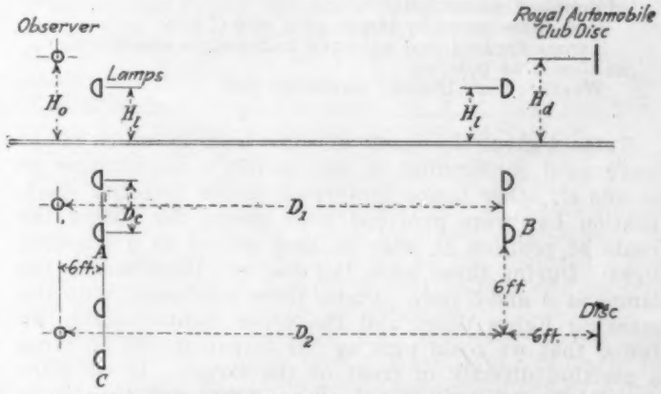
VISIBILITY TESTS

I have made some experiments lately for the purpose of studying these conditions and will discuss briefly some of the data I have collected. Fig. 9 shows the results of the first tests to determine the visibility of the Royal Automobile Club charts. We set up the chart for the first test at an elevation of 4 ft., using an ordinary pair of head-lamps set 39 in. high, higher than the recommended practice of 36 in. This was taken into account in pointing the lamps. We found very quickly, when using plain parabolic reflectors without lenses, that the range of visibility was far beyond the measured roadway that we had provided, that is, beyond 500 ft. We then took the 32-cp. 2-in. frosted bulbs in the same reflectors and found that the targets were visible for 285 ft. when 2 ft. high, 318 ft. when 4 ft. high, and 345 ft. when 6 ft. high. Then, taking a pair of lamps adjusted to the Society's specification as closely as possible, we found that we could pick up a target 2 ft. high 425 ft. away. As these particular lamps were fitted with a two-filament bulb for tilting the beam, we tried the effect of shifting to the upper filament and found that we could pick up the target at a distance of only 153 ft. Naturally, a higher target would not have been detected so far away. During these tests, the disc was not illumined except by the lamps. The pavement was of brick, of the ordinary type, and the night was clear. Table 3 shows the visibility of the disc alone with different kinds of light.

ROYAL AUTOMOBILE CLUB TEST

Fig. 10 covers some tests made to determine the effect of the Royal Automobile Club glare test. The set-up was as before, except that a pair of lamps was placed in front of and to the right of the target. The target was 6 ft. to the left of the left lamp, instead of 6 ft. to the left of the car axis, as in the Royal Automobile Club set-up.

An observer on foot, walking straight toward the centerline of the masking lamps using frosted bulbs,



A = Position of observer's lights in line with lights tested for glare
B = Position of lights tested for glare near disc
C = Position of observer's lights 6 ft. to right of direct line of lights under glare test
D_c = Distance between lamp centers
D_1 = Distance disc is visible when observer is directly back of lights
D_2 = Distance disc is visible when observer is directly in front of disc
H_d = Height of disc center
H_l = Height of lamp centers
H_o = Height of observer's eyes

FIG. 10—TESTS TO DETERMINE GLARE

Lamps Were Placed in Front of the Target. The Observer, Walking toward the Center-Line of the Masking Lamps Using Frosted Bulbs, Determined the Distance at Which the Disc Could Be Seen under Various Conditions

Table 3—Visibility of Disc Against Glare

Disc illuminated by 2-cp. lamp, 32 in. from center of disc

Lamp at position *B* contains 32-cp. 2-in. frosted bulbs

No lamps at *A* or *C*

Observer on foot; weather clear; no moon

$H_o = 5.5$ ft.	$H_l = 39$ in.	$H_d = 4.5$ ft.
$D_c = 28.5$ in.	$D_1 = 70$ ft.	$D_2 = 80$ ft.

TABLE 4—VISIBILITY OF DISC AGAINST GLARE

Disc illuminated by 2-cp. lamp, 32 in. from center of disc.
Lamps at position B contain 32-cp. 2-in. frosted bulbs
Lamps No. 1, beam close to Society's specification, tried at positions *A* and *C*
Weather very cloudy; pavement wet

$H_o = 5.5$ ft.	$H_1 = 39$ in.	$H_d = 4.5$ ft.
$D_c = 30$ in.	$D_1 = 246$ ft.	$D_2 = 300$ ft.

could not see the target until he got within 70 ft. of the masking head-lamps. If he shifted his position to directly in front of the target, he could see the target when 80 ft. away from the front line of the lamps. The results of the tests for visibility against glare are shown in Table 3.

The discs were illumined during the tests by a 2-cp. lamp, 32 in. from the center of the disc. These tests were made on a clear night. We then repeated the tests, using lamps conforming to the Society's specification at the positions *A* and *C*. These lamps further illumined the target. We found that, on a rainy night with wet pavement, we could pick up the target 246 ft. away, when directly in front of the masking lamps, and 300 ft. away, when we were at one side of the lamps and directly in front of the target.

TABLE 5—VISIBILITY OF DISC AGAINST GLARE

Lamps No. 2 on truck against lamps No. 3
Lamps No. 3 at *B*; No. 2 at *A* and *C*

Lamps No. 2, Bright; Beams of No. 3, Tilted

$H_o = 5.5$ ft.	$H_1 = 39$ in.	$H_d = 4.5$ ft.
$D_c = 28.5$ in.		$D_2 = 140$ ft.

Lamps, Bright

$H_o = 5.5$ ft.	$H_1 = 39$ in.	$H_d = 4.5$ ft.
$D_c = 28.5$ in.	$D_1 = 90$ ft.	$D_2 = 120$ ft.

Lamps No. 3 have tilting beam obtained by the use of double-filament bulb
Disc illuminated by lamps at *A* and *C* only
Lamps focused and adjusted to Society's specification as closely as possible
Weather very cloudy; pavement wet

Table 4 gives the result of some tests in which lamps were used conforming to the Society's specification at *A* and *C;* other lamps conformed to the Society's specification but were provided with means for tilting the beam at position *B*, that is, they served as a masking light. During these tests, the disc was illumined by the lamps at *A* and *C* only. Under these conditions, with the masking lights tilted and the other lights bright, we found that we could pick up the target at 140 ft. from a position directly in front of the target. If we were directly in front of the masking lights and they were bright, that is, at normal level, the target would be visible for only 90 ft., whereas, when we were in line with the target, as the car would be when turned out to pass, we could pick up the target at 120 ft. This test was made in cloudy weather and with wet pavement.

It is obvious that, when no other illumination is available and when one does not have a recollection of the objects on the surface of the road as a result of the light from an oncoming car, one's vision of objects beside an oncoming car, when both cars have illumination conforming to the Society's specification, is none too good, and is not safe at the legal speed limit. We escape an abnormal number of accidents because an average driver remembers the obstructions made visible by the meeting pair of lamps, when these lamps are not too glaring.

TABLE 6—VISIBILITY OF DISC AGAINST GLARE

Lamps No. 1 on car against lamps No. 3
Lamps No. 3 at *B*, No. 1 at *A* and *C*

Beams Tilted Just Visible

$H_o = 5.5$ ft.	$H_1 = 39$ in.	$H_d = 4.5$ ft.
$D_c = 28.5$ in.		$D_2 = 90$ ft.

Beams Tilted Very Clearly

$H_o = 5.5$ ft.	$H_1 = 39$ in.	$H_d = 4.5$ ft.
$D_c = 28.5$ in.		$D_2 = 75$ ft.

Lamps Bright

$H_o = 5.5$ ft.	$H_1 = 39$ in.	$H_d = 4.5$ ft.
$D_c = 28.5$ in.		$D_2 = 140$ ft.

Both pairs of lamps adjusted to Society's specification as closely as possible
Both have tilting beams by means of double filament bulbs
Weather very cloudy; pavement wet brick

TABLE 7—VISIBILITY OF DISC AGAINST GLARE

Lamps No. 4 on car against lamps No. 2

Beams Tilted

$H_o = 5.5$ ft.	$H_1 = 39$ in.	$H_d = 4.5$ ft.
$D_c = 28.5$ in.	$D_1 = 58$ ft.	$D_2 = 85$ ft.

Lamps Bright

$H_o = 5.5$ ft.	$H_1 = 39$ in.	$H_d = 4.5$ ft.
$D_c = 28.5$ in.	$D_1 = 70$ ft.	$D_2 = 138$ ft.

Both pairs of lamps were adjusted to Society's specification as closely as possible
Both have tilting beams by means of double-filament bulbs
Weather very cloudy; pavement wet brick

Tilting the Lamps

We then repeated the tests shown in Table 5, having tilting lamps at both positions. We found that, with both lamps tilted, the target became visible at a distance of from 75 to 90 ft., when in a position directly in line with the target, whereas, with both lights bright, the target was visible for a distance of 140 ft. This indicates that, if his vision is not reduced by the glare caused by bobbing head-lamps, a driver is much more likely to pick up an object beside an oncoming car when both lamps conform to the Society's specification than when the proposed new tilted beam is used.

TABLE 8—VISIBILITY OF DISC AGAINST GLARE

Lamps No. 3 on car at *A* and *C* positions against lamps No. 5 on truck at *B*

Beams at C, Tilted; Lamps at B, Out

$H_o = 5.5$ ft.	$H_1 = 39$ in.	$H_d = 4.5$ ft.
$D_c = 28.5$ in.		$D_2 = 190$ ft.

Beams at B, Tilted; Lamps at C, Bright

$H_o = 5.5$ ft.	$H_1 = 39$ in.	$H_d = 4.5$ ft.
$D_c = 28.5$ in.		$D_2 = 160$ ft.

Lamps Bright

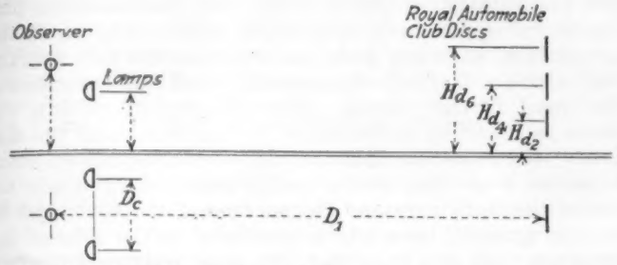
$H_o = 5.5$ ft.	$H_1 = 39$ in.	$H_d = 4.5$ ft.
$D_c = 28.5$ in.	$D_1 = 110$ ft.	$D_2 = 140$ ft.

Beams Tilted

$H_o = 5.5$ ft.	$H_1 = 39$ in.	$H_d = 4.5$ ft.
$D_c = 28.5$ in.	$D_1 = 100$ ft.	$D_2 = 115$ ft.

Both pairs of lamps adjusted to Society's specification as closely as possible
Both have tilting beams by means of double-filament bulbs.
Weather very cloudy; pavement wet brick

Table 6 gives some confirming data secured when lamps of different makes were used. This table also includes some measurements taken when the two sets of head-lamps were directly in line. The results confirm the experience *that*, as soon as one car has turned out to pass another, objects beside and at the rear of the other car that could not previously be seen will become visible. Again, we found that the distance of the visibility is greater when both lamps conform to the Society's specification than when the beam is tilted. Altogether,



D_c = Distance between lamp centers
D_1 = Distance discs are visible when observer is directly back of lights
Hd = Height of disc centers
Hl = Height of lamp centers
Ho = Height of observer's eyes

FIG. 11—EFFECT OF ROAD ILLUMINATION ON VISIBILITY

The Object of This Test Was To Determine the Effect of Illumination Thrown Directly on the Road in Front of the Car upon the Visibility of Objects at a Distance

TABLE 9—VISIBILITY OF DISCS WITH LAMPS NO. 3

$Ho = 5.5$ ft. $Hl = 39$ in. $Hd = 2$ ft., 4 ft., 6 ft.
$Dc = 28.5$ in. $D_1 = 420$ ft.
Illuminated discs just visible. No lamps at all
Discs clearly visible. Lamps conforming to Society's specification, 1 deg. too high
Discs became invisible, when tilted beam was used
Discs still visible, if fairly bright before tilted beam was used
Weather clear; no moon; pavement dry

TABLE 10—VISIBILITY OF DISCS AGAINST GLARE

Lamps No. 2 at B; Lamps No. 3 at C

$Ho = 5.5$ ft. $Hl = 39$ in. $Hd = 2$ ft., 4 ft., 6 ft.
$Dc = 28.5$ in. $D_1 = 280$ ft.
Lamps at B tilted by rocking
Lamps at C full on
$D_1 = 200$ ft.
Lamps at B, bright. Lamps at C, full on. Society's specification, 1 deg. too high
$D_1 = 175$ ft.
Both lamps tilted
Lamps No. 2, Society's specification
Lamps No. 3, Society's specification, 1 deg. too high
Weather clear; no moon; pavement dry.

these data seem to be favorable to the regulations in some states that require that lamps shall conform to the Society's specification and that dimming shall not be permitted. It should be remembered, however, that these tests were made with the lamps stationary and without any change of angle that accompanies driving on ordinary roads.

Tables 7 and 8 give results obtained with other combinations using other types of lamp.

Fig. 11 covers preliminary tests made to determine, if possible, the effect of illumination thrown directly on the road in front of the car upon the visibility of objects at a distance.

We set up three Royal Automobile Club targets, one above another, with the centers 2, 4 and 6 ft. above the ground. We put 2-cp. lamps in little sockets, so that the bulbs were not visible in front, and provided rheostats, so that we could adjust the illumination until the target was just visible. We found that, at a distance of 420 ft., if the light from a pair of lamps was thrown on the target with the beams tilted, it disappeared, if the illumination had previously been adjusted so that the target was just visible. If, on the other hand, the discs were illumined so as to be fairly bright, they would still be visible with the tilted beams turned on.

ILLUMINATION CONFORMING TO THE SOCIETY'S SPECIFICATION

If the regular Society specification illumination was used, on the clear night during which we were working with a dry pavement enough light was thrown up from the road to compensate for any masking effect of the illumination on the road and, as a result, the targets were still visible. These data are too limited to be used for drawing broad conclusions but they indicate that an object that is reasonably well illumined will still remain visible in spite of any masking effect of light from Society specification lamps, but that, just at the threshold condition, such as that of an individual in dark clothes on a black macadamized road, the illumination in front may interfere.

Table 9 covers some tests with a set-up like that of Fig. 9 and directly comparable with the results of Tables 6, 7 and 8, except that we had adjusted the lamps at the A and C positions about 1 deg. too high. We found that, when we had raised the angle 1 deg., the target placed at the side of the opposing lamps became visible at 200 ft., instead of 140 and 160 ft. as in the tests of Table 8, and became visible at 175 ft. with both lamps tilted. We, of course, had tilted the lamps at A, 1 deg. less than previously, as compared with the tests in Table 8. This emphasizes once more the great gain in visibility to be obtained when lamps conforming to the Society's specification are tilted higher than specified. It is this noticeable gain in visibility resulting from carelessness in keeping the lamps pointed down to the required angle that leads so many persons to believe that our present specifications are entirely satisfactory.

The tests just mentioned are, of course, exceedingly limited, but they show how a start might properly be made in checking up the present specifications or determining upon a desired revision.

INVARIABLE AND ASYMMETRICAL LIGHTING

BY P. W. COBB*

ABSTRACT

A FIXED and invariable lighting system attached to the body of a car cannot satisfactorily fulfil the almost diametrically opposite functions of enabling a driver to see the road ahead and, at the same time, of allowing the driver of an approaching vehicle to see the road ahead of him. The effort to obtain safety has brought increased candlepower and the result has become an offensive competition between drivers, particularly noticeable on unlighted thoroughfares.

Excessive brightness of certain areas within a field of vision acts antagonistically to vision within these areas. A source of such brightness is the headlight of an approaching motor-car. Other causes of interference with vision are overlighted instrument-boards and bright areas in the roadway produced by tipped-down headlights.

The most discouraging feature of the standardization of headlights is the fact that photometric calculations apply only to certain conditions and that a slight variation of these conditions will upset the whole scheme. The author is in sympathy with the suggested plan of asymmetrical illumination and believes that the essentials of such a plan should include (*a*) a beam of moderate intensity to illuminate the right edge of the road-

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way at a distance ahead that would be safe for slow driving and (*b*) a marker-light on the left side of the car. This would involve some slowing-down and a switching-over from the straight headlighting system, which each driver would use again as soon as a vehicle has been passed and the highway is clear.

AS a representative of the Illuminating Engineering Society on the joint committee that Mr. Crane mentioned, I was impressed by the fact that, although a certain amount of benefit might be achieved by the proper design and adjustment of the lighting system attached to the body of the car, so fixed and invariable an arrangement could never satisfactorily fulfil the two-fold, positive and negative, purpose of enabling a driver to see the road ahead and, at the same time, of allowing the driver of an oncoming vehicle also to see the road ahead of him. Granting that the enforcement of such a plan is practically possible, it is still an attempt to standardize a device to serve two purposes almost as diametrically opposite as are the north and the south poles.

In the interest of safety, the tendency naturally has been toward beams of increasing candlepower. The difficulties with glare have been met by increased candlepower, which again has increased the difficulties of the driver of an oncoming machine, so that the result has become, in effect, an offensive competition. This applies more particularly to traffic on unlighted, especially rural, thoroughfares. In the city, with very moderate street-lighting, I should prefer to drive for the most part with no headlights at all, or at most with marker-lights, to enable other drivers to locate my machine with ease.

Bright Areas Within Field of Vision

Something is already known about the physiological fundamentals applying to the case. In general, areas within the field of vision that are much brighter than the area that must be seen act antagonistically to vision within that critical area. Such areas are light sources within the driver's field of vision; and the worst of these is the headlights of approaching motor-cars, owing to their high candlepower and their proximity to the critical area.

An impediment to safe night-driving that I believe is commonly overlooked is an overlighted instrument-board. The light falling on each instrument should be no more than is sufficient to read its dial when one's eyes have become adapted to the road brightness; hence, the lighting here should be not only low but nearly uniform, as it never is.

Another cause of interference with adequate vision is the bright area in the roadway near the machine, produced by tipped-down headlights, which may easily be too close to have any great safety-value for fast driving, and which will effectively prevent the driver from seeing the road farther ahead. The flux-density within the beam is inversely proportional to the square of the distance; the resulting illumination, on a smooth level road, is worse than this, owing to the diminishing angle between the light rays and the surface of the road, and is, on this account, inversely proportional to the cube of the distance. At 100 ft. ahead, the road surface therefore receives only about 6 or 7 per cent of the amount of light that falls at a distance of 40 ft.; that is to say, the road at a distance of 100 ft. is as black, compared with the road 40 ft. ahead, as is printer's ink on white paper. This of course presupposes a level, smooth road-surface and a uniformly intense cross-section of the beams from the headlights, both of which are either exceptional or non-existent.

Photometric Calculations Apply to Exceptional Cases

The most discouraging feature of any plan for standardizing automobile headlighting is the fact that, in the nature of the case, our photometric calculations can apply satisfactorily only to what is almost an exception among the many situations that arise. It requires only a slight roll in the road, or a passenger or two more or less on the rear seat, to put our scheme into the same class with the proverbial "best laid plans of mice and men."

I am inclined to sympathize with Mr. Crane's general plan of using a special—perhaps the best is the unsymmetrical—system of lighting to meet traffic conditions, including passing on country highways. The essentials seem to be (*a*) a beam of moderate intensity to illuminate the right edge of the roadway at a distance ahead that would be safe for slow driving and (*b*) a marker-light on the left side of the car. Such a system might be designed so as to spare the vision of the other driver under most conditions. It would involve some slowing-down and a switching-over from the straight headlighting system that each driver would use again as soon as he has passed a vehicle and has the highway to himself. This, in turn, would necessitate a certain amount of courtesy, which is not more impossible with reference to the use of lights than it has been with reference to the use of the streets and highways in general. Legal enactment, with suitable police activity, and the understanding that results from educational propaganda have made the streets comparatively safe; and they can do the same for the other.

LESSENING OF GLARE BY COLORED SHIELDS

BY J. W. LORD*

ABSTRACT

ALTHOUGH the author has been very careful to keep the head-lamps of his car in focus and properly pointed, protests are still heard from approaching motorists. No matter how accurately focused the head-lamps may be or how accurately directed, to conform to present rulings, depressions in the road and variations of grade cause the lights to be seriously noticed. He believes that the range of head-lamps should not be reduced further, but suggests that safety and comfort may be obtained from the use of a shade or colored glass to lessen the glare from approaching cars, and also from the sun.

SINCE the agitation for better headlighting has come up, I have been very careful to keep the head-lamps on my car in focus and properly pointed, with the idea of doing less dimming. Although I know I am much safer, certainly can see more of the road and have no fear of running over some stray pedestrian, it is most interesting to listen to the various epithets hurled at us as we pass motorists coming from the other

* M.S.A.E.—General manager of the service department, Harrolds Motor Car Co., Long Island City, N. Y.

direction. These vary from mild protests and shouting of "lights," to stunning examples of concentrated profanity. In some cases, I have had persons steer right at me to indicate their displeasure.

Effect of Depression in Road

It seems to me that no matter how accurately headlamps may be focused, or how accurately directed, to conform to present rulings, it stands to reason that depressions in the road and variations in the grade are bound to lead to a situation in which bright lights will be seriously noticed by motorists on the road at night.

I think it would be a mistake to reduce still farther the range of head-lamps. Perhaps the greatest safety and comfort when driving at night will be with bright lights and a shade or colored glass to lessen the glare from oncoming cars. I rather favor a device of this kind because it can be used not only at night but also in the late afternoon when one is obliged to drive straight into the sun. My own experience has been that driving into the sun is far more uncomfortable than driving into headlight glare.

IMPROVEMENTS IN HEADLIGHTING

BY R. N. FALGE[10]

ABSTRACT

DEFICIENCIES in headlighting equipment are not inherent in the system of beam specification but are due to the fact that the specification has not yet brought about ideal practice. At no time has progress been so rapid as at present. Experience, in the few States in which any well-conceived administrative plan has been attempted, is crystallizing laws, regulations and procedure in a promising manner. In many States no provision was made for an administrative department or for educational work.

Simple principles of design can further limit the variations of the lower part of the beam, but, under certain conditions, interference with approaching drivers will exist with the best fixed-beam equipments. The opinion seems to prevail that means under the control of the driver should be provided for depressing the beam through a small angle; and this is made possible most simply and inexpensively by merely switching from one filament to another that is slightly offset in the same bulb.

Large frosted bulbs in parabolic reflectors may provide satisfactory illumination under certain favorable conditions, but not under the more difficult conditions, such as touring over unknown roads having dark-colored surfaces, and in fog or haze. Frosted bulbs provide too little illumination to render visible objects several feet ahead and too much to be satisfactory from the glare standpoint.

I BELIEVE I am correct in saying that most of us who have been following the headlighting problem for years are satisfied that the deficiencies found are not inherent in the Illuminating Engineering Society system of beam specification, but will agree that this specification of itself has not as yet brought about ideal practice. And that is an important distinction in a matter in which steady progress is being made each year toward realizing the practical details of construction, operation, public administration and education that are implied in the Illuminating Engineering Society system. At no time has this progress been so rapid as at present. In only a very few States has any well-conceived administrative plan been attempted, but the experience of these few is crystallizing laws, regulations and procedure in a promising manner.

It seems to me that the situation in most of the states at present should not be regarded as a failure of the Illuminating Engineering Society system. In some states approvals are under an early specification that could be met by practically any kind of device, even by the parabolic reflector and plain cover-glass combination that was recognized as being entirely inadequate in the revision that the Illuminating Engineering Society and this Society made some years ago. In many of the other states using the latest specifications, no provision is made for an administrative department or even for educational work.

Features of design and manufacture, making for greater precision in the various elements of a head-lamp, have been greatly improved, but the variation in results can be still further limited by the adoption of simple principles of design of the redirecting cover-glasses and reflectors that are effective in keeping the variations in the lower part of the beam where they do no harm.

Interference Possible Under Best Conditions

But, as Mr. Crane has pointed out, with the best fixed-beam equipments now in use properly adjusted and aimed, under certain conditions undue interference will be caused with approaching drivers. A few of us have long urged that means should be provided under the control of the driver for depressing the beam through a small angle so that the Illuminating Engineering Society system may adequately meet the requirements of motorists. It appears that this has now become the prevailing opinion. Considerations of cost, and of mechanical and other difficulties with earlier systems of control, have greatly limited the application of this principle, but, since this has been made possible most simply and inexpensively by merely switching from one filament to another that is slightly offset in the same bulb, large-scale application has become commercially attractive. These depressible-beam equipments, by whatever means operated, compensate not merely for conditions of road contour, surface roughness and car springing, but also for slight service variations in the adjustment and aiming of equipment from the standard implied in the Illuminating Engineering Society system for a single fixed-beam. The downward tilting of the beam also supplies light near the car, a feature that is most useful when passing other cars.

Frosted Bulbs Inadequate Under Difficult Conditions

At the 1925 Spring Convention of the American Institute of Electrical Engineers in St. Louis, Mr. Hunt stated[11] that very satisfactory road illumination, sufficient for speeds up to 35 m.p.h., can be obtained from head-lamps with from 36 to 40-cp. filaments and with large frosted bulbs in parabolic reflectors. This may be true under certain favorable conditions, but is not the case under the more difficult conditions of driving, such

[10] M.S.A.E.—Engineering department, National Lamp Works of the General Electric Co., Nela Park, Cleveland.

[11] See the *Journal of the American Institute of Electrical Engineers*, May, 1925, p. 476.

as in touring over unknown roads having dark-colored surfaces, and in fog or haze.

The S.A.E. Recommended-Practice values were established only after a long and careful quantitative study under actual driving-conditions, and provide not only for safety but for a reasonable amount of comfort. The candlepower specified at a point 175 ft. ahead of the car is 25,000, whereas the candlepower just above the headlamp level must be limited to 800 to avoid dangerous glare. The frosted-bulb arrangement provides from 3000 to 4000 cp. at both points, far too little to render visible objects several hundred feet ahead, under some of the conditions of ten encountered in service, and far too much to be satisfactory from the glare standpoint. Without wishing in any way to discourage the careful study of all the possibilities that may lead to better driving-conditions at night, I have felt the need of pointing out this enormous gap between what is needed on and above the road, and what is provided with the frosted bulb.

SPECIFICATIONS FOR HEADLIGHTS

BY W. D'A. RYAN[12]

ABSTRACT

ALTHOUGH agreeing in general with the sentiments expressed by Mr. Crane and Mr. Hunt, exception is taken to the statement that the solution of the headlighting problem is to be found in diffused lighting, because it has not sufficient range, is too glaring and is too dangerous in a fog. The trouble is said to lie not in the specifications but in the devices that they are supposed to cover. Suggestions are offered regarding modifications that might advantageously be made in the present specifications, and a detailed summation is given of the requirements considered essential to a first-class headlight. The statement is added that a headlight embodying all the points enumerated, while at the same time using a 21-cp. bulb, has already been perfected.

I AM greatly in sympathy with the many excellent points brought out by Mr. Crane and Mr. Hunt in their papers but I fear that the use of the frosted-bulb lamp is not the final solution of the problem. It has not sufficient range, is too glaring and is extremely bad in a fog. The Illuminating Engineering Society's specifications are not so much at fault as are the lighting units that they were prepared to control; and, up to the present, nothing better in the way of specifications has been offered as a first line of elimination in keeping freak lights off the market. Until some marked improvement has been made in automobile headlights, a radical change in the specifications does not seem warranted, except possibly a reduction in the allowable maximums at the *C* and *D* points. Just so long as 2400 cp. is allowed at *C*, glare is bound to exist.

The present crude remedy adopted by the automobile-headlight adjusters is to depress the beam, either by adjusting the universal-joint or by bending the forks until the lamps do not glare. An arbitrary adjustment of this kind results in a bright patch of light 50 or 60 ft. in front of the car, with practically nothing beyond, and produces a very dangerous driving-light. Until a reasonably long-range non-glaring light, say at 200 to 300 ft., is available, no form of specification will do much to improve the situation.

I wish to go on record as being opposed to the so-called hot-spot. The tendency to produce a small spot with 40,000 or 50,000 cp. or more, for high-speed driving is bad, because the spot is usually too small to be of great value, especially on curves, and such a light striking the road at a critical angle, particularly when the surface is more or less polished or the night is wet, introduces a new point of glare coming from a lower angle that is even worse than the direct rays from the lamp. In other words, it introduces a new element of dangerous glare that should not be tolerated. If the lumens concentrated in this small spot were given a proper lateral spread, the maximum candlepower would naturally fall, but the light would be less glaring and more useful. I believe that we shall ultimately draw our specifications in lumens over a given area rather than in candlepower. When this is done, a much more rational specification can be formulated and applied. In any case, I do not think that the maximum candlepower in any part of the beam should exceed 20,000 or 25,000. Even this, with a properly balanced beam, may be more than is necessary.

In addition to limiting the maximum candlepower, the time has arrived when we must give more consideration to the lateral light for illuminating the gutters, reading road signs and showing up clearances when passing cars in congested traffic, rather than developing along the lines of maximum candlepower for high-speed driving, which does not represent the major function that a headlight is called upon to perform in the interest of general safety.

In the last 3 years I have given considerable study to headlighting requirements and it has become clearly evident that, with existing types of headlight, it is impossible to have both good long-range light and absence of glare. When the lamps are adjusted for range, they glare, and, when adjusted for non-glare, they have no range. To accomplish both results, the parabolic reflector must be abandoned and something with an entirely different light-characteristic substituted.

It is not difficult to design a headlight to satisfy the man behind the wheel, but it becomes a real problem when the driver facing the lights is taken into consideration; and it is right here that the majority of the headlights fail today. Before an automobile headlight can take its place as a decided improvement over existing equipment, it must meet the following specifications:

(1) It should be a non-glaring unit having a range between 200 and 300 ft. on a level road; should be non-focusing and capable of operating with lamps of any form of concentrated filament or candlepower without change of focal adjustment

(2) The light distribution should be of fairly wide characteristic with reasonable depth and should be homogeneous, with a gradually increasing intensity, from a point near the machine to the most distant point; and the reflected beam should not rise above the horizontal. Sufficient light, from even a macadam-road surface, is available to take care of softening the cut-off above the horizontal at long range. The area of greatest intensity should not be concentrated into a small spot of high candlepower, but should have a reasonable lateral divergence. It is important to bear in mind that a very intense spot, particularly on a wet road-surface, introduces a new element of reflected glare that should be avoided

(3) A reasonable amount of light should be projected

[12] Director of the illuminating engineering laboratory, General Electric Co., Schenectady, N. Y.

at right-angles to the plane of the main beam, and even a few degrees to the rear, so as to light up the gutters and curves, make the turns safe in difficult places and make possible the reading of road-signs on either side without the use of spotlights or other auxiliary lamps

(4) Sufficient light should be thrown on the front of the machine, that is, the radiator, forward wheels and bumper, so that they will be clearly visible; and, if one light fails, there should be no chance of mistaking an automobile for a motorcycle. The cut-off of the beam should be such that there will be no upward high candlepower rays to scatter into the fog and reduce the visibility

(5) The dispersion of unreflected light to illuminate trees and telegraph poles, and give a general vista without glare should be general so that distance can be judged at night as well as in daylight driving. If the non-glare feature of the unit is further improved by lighting up the front of the machine and the general surroundings, the intensity of the source will become less brilliant by simultaneous contrast. Furthermore, the main beam should be of such a nature that it will become even less brilliant as a car is approached; this, in turn, will improve the ability of the oncoming driver to see beyond the approaching car at the critical moment, and in other ways will add a sense of comfort or feeling of security in driving.

(6) The lights should be definitely focused for city and country driving, so that no necessity will exist for dimming, tilting, or other manual operations, which, in the majority of cases, with the present increased automobile traffic, are impracticable, unless the lights are operated at the low point practically all the time

From a mechanical point of view:

(1) The lamps should be adaptable to modification of design to meet the esthetic lines of the car and embody the elements of true art; this, at a glance, suggests that the unit is primarily a functioning light-source rather than a decoration

(2) It must be sufficiently rigid in construction so that it cannot get out of adjustment

(3) It should be dustproof and rainproof, and a simple means of opening the door should be provided so that the replacing of the lamp or the cleaning of the reflector can be done without the use of tools, unusual exertion or the disturbing of the adjustment

(4) A simple means of adjusting the beam should be provided which will not require bending of forks, difficult manipulations, or technical knowledge; in fact, so simple that anyone can make the adjustment and little excuse will exist for failure to comply with state or police regulations

(5) The headlights must be produced at a cost that will not make their use prohibitive even by low-priced cars, and they should not be subject to wide variations in production

I believe that these specifications are well within the range of possibility and can be met without great difficulty and at a reasonable manufacturing cost.

DISCUSSION

H. M. CRANE:—Obviously, my paper was not prepared to present a solution of the headlight problem. It was intended as a synopsis of what the headlight problem appears to me to be. The committee members seem to be fairly unanimous on one point, at least, and that is, the deficiency of the quality of the headlighting equipment of many automobiles produced today. We know, and I am sure that those who attempt to enforce the law will emphasize, that the public knows very little about headlighting regulations in any form.

Before we can have fairly good road conditions, what we must have is a campaign of education. I believe that the Research Committee should start a campaign of education first among its own members, then let the good work spread to those who are responsible for putting the cars into production. Inasmuch as the cars are made to sell at a price, no part of the equipment can be made better than the public demands for that particular part. That means the education of the managers of the car-building companies, if it should prove to be desirable, and education of the car users as to what the equipment is intended to do and what they must do to make it do it.

T. D. PRATT[13]:—I am entirely in accord with the principles that Mr. Crane has outlined. I have never been convinced that the principles on which we have been trying to regulate headlighting are correct. We have assumed that the problem is, How much light does the driver behind the lights need to see? Is not the problem rather, How much light must there be on the roadway in order that the driver may see?

Entering into the problem, of course, come the direction and the source of the light. We all know that, when driving on a city street illuminated by 100-watt lamps every 200 ft. on each side alternated so that there is a light every 100 ft., sufficient light with which to drive is provided, but if photometric readings were taken almost anywhere, say 100 or 200 ft. in front of the car, the readings would never reach the photometric reading of the candlepower required by the present specifications. We not only do not need the candlepower that the present specifications allow to be projected on the roadway, but I am not sure that we need the light from the exact position from which it is projected. It may not be practicable, for a great many reasons with which I am not thoroughly conversant, to mount the headlights otherwise than they are now mounted, yet it has been suggested that, if the headlights were mounted on the roof of a closed car and, say, on top of the windshield of an open car, a very much better driving-light would be obtained. That, however, does not take into consideration the effect that would be produced on the oncoming driver. Undoubtedly, with anything except the most mildly diffused light, a glare would be directed into his eyes. It has also been suggested that the lights be mounted on a level with, or beneath, the front axle and that the rays be sent parallel with the surface of the road. I think that most of us who have had experience in driving horse-drawn vehicles realize that a lantern hung under the wagon body gives a surprisingly good road illumination for the distance to which it is necessary to see at the speed at which the vehicle is going; yet the candlepower could not possibly have reached 100. It probably was so small that at a distance of 25 ft. it could not be read photometrically.

DRIVING THROUGH A TUNNEL

Another factor that Mr. Crane touched on enters by way of contrast. With a beam-controlled electric headlight, on a road that has no other illumination on a dark night, we are in effect driving through a tunnel. The objects on either side and overhead are entirely undiscernible to us. It is a question whether the eye-strain that is set up under these conditions is conducive to good driving. Personally, I do not think it is.

It has been stated that the eye will adjust itself almost instantly without undue strain to a difference in bright-

[13] M.S.A.E.—General manager, Motor Truck Association of America, New York City.

ness of 60 times; that is, the eye can switch from one object to a second having a brightness of only 1/60 that of the first and can visualize the second object instantly. When the difference in brightness increases beyond that intensity, momentary periods of blindness occur. Without realizing it, is it not possible that we reach a point at which going at 30 m.p.h., or 44 ft. per sec., becomes dangerous?

Under those conditions, inasmuch as it frequently takes 2 sec. for the eye to adjust itself to the difference in intensity, we have, in effect, a period during which a driver drives the car without knowing what he is doing, that is, he is blind for a distance of 88 ft.

A MEMBER:—In Australia, from where I come, the headlight question has been very important, as the roads do not compare in any manner with the splendid roads in America. There the roads are winding, and every 100 yd., probably, is a stump or a root of a tree that requires dodging.

To endeavor to carry out the headlight regulations adopted by the Society would be almost useless to us. In our country the lights are elevated on the trees; and, when approaching a car, you will easily see the light for a mile before the car reaches you. That is on account of the winding roads and the obstructions which, in the way of trees, are before you.

The police department carries out all the work, and has evolved a system by which headlight glare has been eliminated. That is saying considerable but it is a fact. The system we have evolved gives this advantage: We do not care whether an approaching car blinds us, we still have means of passing that car in safety, and the approaching driver can pass us without fear of striking our car.

A headlight with a parabolic reflector, when the bulb is in the vertical position, projects all the beams immediately forward. Working on the focusing principle and moving the bulb back, we get the result of spreading the light. By doing so, the approaching driver drives into a black spot. The center of the reflection is all cut out and the rays diverge. We found that many stray rays come across the road. The effect is that no rays come from the center. As Mr. Hunt has mentioned, the range over which the eye can see clearly is 60 to 1. If you are driving with a beam concentrated ahead, the driver of an approaching car is discommoded by your light.

PAIR OF WINDINGS GIVES THREE POSITIONS OF BULB

By a control that consists of a pair of windings separated one from the other, we control the light with two buttons that throw the light in or out, or gives an intermediate position, so that we have three positions of the bulb in relation to the reflector. If an approaching driver is discomfited by our light, we spread the light but do not dim it; we bring the light immediately in front of the car and to both sides, so that he is driving, as I have said before, practically into a black spot. Then, again, though we may be blinded by his rays, the amount of light that is diverged to both sides of the road enables us to see the roadway and his car clearly as we pass.

Under the conditions that arise on a roadway when a number of cars are passing one after another, we spread the light, because sufficient illumination is provided from the lamps of other cars to see the roadway, and by spreading the light we are not driving into a tunnel. We see both sides of the road and, as another car passes, the driver sees us clearly; in many cases, in which the lights are set back slightly, the front of the wheels and the mud-guards are visible.

C. E. GODLEY[14]:—We have taken a set of approved lenses with plain parabolic reflectors and 21-cp. clear bulbs and adjusted them to obtain readings to get by the *D*-point, *C*-point and *A*-point. The value at the *D*-point was 550 cp. which is less than the maximum of 800 cp. permitted at this point, at *C* 970 cp., at *A* 4900 cp., at *B* 26,000 cp., at *P* 16,000 cp., and at *Q* we had 800 cp. Then we took the same set-up, put in 21-cp. frosted bulbs and the readings were 2400 cp. at *D*, 3100 cp. at *C*, 4000 cp. at *A*, 5300 cp. at *B*, 5100 cp. at *P*, and 3900 cp. at *Q*.

When we took the same set-up with the frosted bulbs and tilted the lamps to get by the *D*-point, which is supposed to be the glare point for an oncoming driver, we had 780 cp.; at *C* we dropped to 970 cp.; at *A* to 1300 cp.; and at *Q* to 1500 cp. You can see that by using the frosted bulbs, to have light enough to drive by, we are above the glare point. If we drop the rays down to a point at which the oncoming driver would not be blinded we could not see ahead of the car for any distance.

A MEMBER:—From a preliminary reading of Mr. Crane's paper I got the idea that the present regulations are all wrong, that it is practically impossible to get satisfactory results with the regulations at present in vogue and that they should be discarded so that we can start on a new track. Another impression I got by reading between the lines of the paper was that it discusses light instead of a well-regulated and directed beam.

I cannot subscribe to the idea I have mentioned and I do not believe anyone could subscribe to it who has really looked into the problem and has driven a car in Massachusetts or in New York State under conditions corresponding to the regulations. I am glad to know that that is not Mr. Crane's idea and that it is not Mr. Hunt's idea; and I want to get clearly before us all just what the situation is. What I get from them now and what I can subscribe to is that the system has some difficulties, just as any system. It is not perfect, and difficulties have been found in enforcing the laws throughout the different states. Considerable remains to be done by us in the Society as boosters, and by the state officials but, in general, progress is being made. I get from them, and I can subscribe 100 per cent to the idea, that perhaps we ought to put the maximum limit on the side-points of the road lights. The side-points are liable, on bad roads, to flash up and hit the other driver in the eye, as he approaches in another car.

The use of a spotlight and a little different arrangement of lights, or an additional light, would help. All who have driven with a well-regulated spotlight know that.

RESEARCH SHOULD BE CONTINUED

I get the idea that we should not stop here. Let us go ahead, and then, through the Research Committee, continue the research until the system becomes about 99.99 per cent perfect. I think we should all be in favor of that.

After all has been said and done, as I view this headlight problem, it will be pretty easy. The problems are two and both have been included in these regulations. The first is plenty of road light, enough but not too much, and a distribution such that you can see not only the stumps straight down the road, but some on the side, some right in front of the car and so on. The other is in watching the driver who is coming toward you and in not being put off the road by his glare. These are all this "A. B. C. stuff" means.

[14] M.S.A.E.—Mechanical engineer, Edmunds & Jones Corporation, Detroit.

I have had considerable of "grief." I happen to be familiar with the grief that the Ford Motor Co. gets in connection with lights. Complaints are received because some cars operate in one condition, some in another. But, after all has been said and done, I think we are on the right track. I am certainly not in favor of throwing away a thing that, after 7 years of development, has progressed as far as this has and that stands as one of the best pieces of automotive legislation that the Country has ever seen. I believe in supporting it in spite of its defects. Some difficulty, of course, will be experienced in enforcing it; but I have driven thousands of miles through Massachusetts with officials of our company and the general opinion has been that the system is pretty good.

T. J. LITLE, JR.[15]:—I thoroughly believe that the present regulations as recommended by the Society are good, but the enforcement is bad and always has been bad. Enforcement is difficult in many states. In Pennsylvania many years ago a State law was passed that every elevator shaft in the State had to be equipped with a safety device so that the elevator could not be operated if any door of the shaft were open. Obviously, that was a good protective measure. After the law had been passed, owners of buildings were compelled at great expense to equip the elevator shaft with these automatic devices, which were like little burglar-alarms; but the law neglected to say anything about enforcement; and what do you suppose resulted? Everybody put the devices in but did not use them after they had been put in. No inspector ever came round. That is the way it is in many states with regard to headlighting regulations. They are not enforced. About five states in this Country make an attempt to enforce them. That is the reason you can see a car a half-mile or a mile away, with an exceedingly great glare that pierces your eye and blinds you.

In Fig. 1, the point *D* is supposed to be another driver who is approaching. It has been decided by very careful tests that the illumination at that point should not exceed 800 cp. Conscientious manufacturers try to get below that amount. But we do not get that amount of illumination on the road; notwithstanding the fact that a car may leave the factory so adjusted, it is not maintained so.

PRESENT LAWS SHOULD BE EXPLAINED AND ENFORCED

The State of Massachusetts has many stations to which drivers may go and have their cars tested for a nominal fee. These stations have greatly improved driving conditions. What we as a Society should do is to urge the state authorities to explain why the present laws are in force and to enforce them. I am not a believer in discarding a good thing to replace it with another so-called good thing. I am not a believer in building new models of cars every year, for that reason. I am a believer in improving the old car of last year, putting in better parts and better materials, but perpetuating a fundamentally good model. The same thing applies exactly to headlights. I believe that the older laws can be gradually improved and that they have been improved. More improvement in headlights has taken place in the last year than in all the history of the industry. Lenses have been built that spread the light out on the road and reduce the glare. All we need do at the present time is to see that some of these regulations are improved. We want them improved. Do not think that some of the regulations prepared by the Illuminating Engineering Society and this Society have not been given careful consideration and are not good; they were recommended, after both laboratory and road tests, by between 50 and 60 different persons, not necessarily scientifically inclined, not necessarily engineers, but all of them drivers.

A MEMBER:—New Jersey has no particular criticism to make of the present specifications. We have welcomed them. Prior to their formulation, we had been groping about in our own way, trying to find a solution of the glare problem. We are willing to try to enforce any specifications that the Society may recommend, because we have the utmost confidence in the ability of the Society to make specifications that will keep abreast of the progress in lighting.

In the matter of approved devices that have been applied to cars in our State, we began enforcement shortly after the list was adopted, on July 1, 1923. Everything was threshed out in a State-wide drive. Consequently, very few cars are without approved equipment. How the equipment is applied is a different matter. When we investigated that subject, we found that we were up against a wall. We found that the theory did not work out so well. Difficulty was experienced in the matter of the focusing devices. Improper door construction also caused trouble. On one of the most popular cars, not a cheap car either, but one ranking high as to number in this section, it was practically impossible last year to take off and replace a head-lamp door, because one or more of the springs that held the door would break in almost every instance. These are some of the things that we encounter in endeavoring to enforce the law. The theory is fine; but when an effort is made to work with some of the equipment, enforcement becomes difficult.

ENFORCEMENT DIFFICULT BECAUSE OF POOR LAMP EQUIPMENT

We feel that we are rather close to the wall. We cannot do anything else. We have the machinery to make drives, have been making them, are making them still in a small way, and could make them in a really intensive way. But why should we do so when every month, every week in fact, thousands of new cars are dumped into the State that are just the same as those we have had in years past. The mechanism is poor, and very little, if anything, in the way of focusing is done to them by the lamp-makers, the car builders, or the distributers in the State, before they are sold to the public. They go on the road in that way. It is beyond our power to try to keep abreast of them. We might almost as well try to bail out the ocean, unless something is done at the source.

At a meeting of the Society some years ago, General Manager Reeves of the National Automobile Chamber of Commerce made a plea that the engineering department rather than the purchasing department of the various manufacturers dictate the lamp instructions. I think that this was very aptly expressed. So far as we can learn in New Jersey, the purchasing departments are still dictating what head-lamps shall be used.

R. E. CARLSON[16]:—I should like to add two points to this discussion. The previous speaker mentioned what the manufacturers might do in the matter of furnishing better equipment. I should like to say something about what they might do toward furnishing better service on the headlights that they sell. Every manufacturer, every garage man, every dealer, every salesman has an obligation to perform to the man to whom he delivers

[15] M.S.A.E.—Chief engineer of the Lincoln division, Ford Motor Co., Dearborn, Mich.

[16] S.M.S.A.E.—Engineer, Bureau of Standards, City of Washington,

a car. They ought to discuss good headlighting. They talk about pick-up, acceleration, balloon tires, and so forth, but do not say a word about good headlighting. To get information, one must go to the source from which the cars come. If I buy a car from John Jones, I look to him for headlight service.

One other point has reference to equipment. Focusing seems hard to the average car-owner. I hope that we may find some way to avoid the operation of focusing, so that a car operator need only aim his lights down the road. I have in mind some form of combined fixed-focus lamp and reflector, which would eliminate about 50 per cent of the present difficulty.

DR. C. H. SHARP[17]:—Mr. Crane's paper does not contain many statements to which I can take exception. A great many pertinent facts, however, have not been mentioned.

We have had the deficiencies of the present system of headlighting pointed out to us at great length, but we have not heard any real discussion on the part of the authors of the papers as to just how important, as practical matters, these deficiencies are; nor have we heard anything as to the counterbalancing advantages of the system that we have.

Like all engineering work, this system represents a compromise. It is an engineer's business to state just how far he can carry one factor and how far he can carry another factor that will conflict with it. He must strike a balance between them and, in the case of the headlighting problem, a balance has been sought between the glare that other drivers can reasonably be asked to endure, and the illumination that the driver of the car carrying the headlights must have. The specifications represent, as a result of experience, experiments and tests, a compromise on that subject, which, as a matter of fact, in places where it has had a fair chance and due enforcement, is working out to pretty good advantage.

REGULATING VERSUS DIFFUSING SYSTEM

Conditions on the roadway would be intolerable if we had not some reasonable set of regulations; and this set is working its way through. The argument, as I read it, seems to be that the present system is bad and ought to be abolished, and a change made to the only other kind of a system that I can imagine, the diffusing system. What does it mean? In the regulating system, an endeavor is made to throw the light where it is wanted and keep it away from where it is not wanted; in the diffusing system, the light is smeared all over the landscape, regardless of whether it is wanted there or not. The light that should be on the road is going up into the treetops and into the eyes of other drivers. That kind of solution is not very creditable to engineers; and to say that the regulating system is a failure, because the apparatus that is used in the equipment is so bad that it cannot accomplish the desired end with an average low-priced car, that the average low-priced car is so cheap that it cannot afford to carry good equipment, anyway, is a confession that I do not believe engineers are willing to make.

The public has accepted many expensive improvements in automobiles and has gladly paid the price. It accepted four-wheel brakes because it thought it was getting something for the money. It is accepting balloon tires, thinking it is getting something for the money. It will accept really good well-constructed head-lamps if it thinks it is getting something for the money. I am sure it would be getting good value for the money.

REMEDY LIES IN GOOD HEADLIGHTS WITH DEFLECTING BEAM

I cannot agree with the statement that no improvement can be made without a great amount of fundamental research. Two lines of improvement lie right before us. One is to put on good head-lamps that will stand adjustment. Adjust them on new cars before sending them out and construct them so that they will stay adjusted. Another is to adopt some form of deflecting beam to be used under the conditions required in passing other cars.

Tests that have been made at the National Physical Laboratory in England of the results of using the Royal Automobile Club's target as compared with the figures given in the specifications of the Illuminating Engineering Society and of this Society have shown that pretty much the same distribution of light satisfied either test. If such is the case, we are well in conformity with the best English thought on the subject.

We have a system of headlight regulation that is applying over a very large part of this Country. It is applying in states that register more than 50 per cent of all the cars in the Country and in provinces of Canada representing more than 50 per cent of all the cars in Canada. The situation is such at this time that a car can start in Maine, be driven across the Country, and not be held up on account of the headlights. It is such that a manufacturer can put a form of standard equipment on a car that will be accepted in all the states. The system is progressing and is getting better and more universal all the time. Think what it might mean to the automobile industry and to the public whom it serves, if something were done by a part of this Society, or by anybody else, that would shake the confidence in that system. We might easily find ourselves out of the frying-pan and in the fire. Even if another system were somewhat better, it might not be advisable to use it. I am in favor of finding the best system; but let us go very carefully in throwing any undeserved discredit on the present system; let us push it as fast as we can as being the only system in sight that has the prospect of universal adoption.

A. W. KALLEMEYER[18]:—So far as New York State is concerned, we have just begun to enforce the law. We have had the headlight law since last July but began to enforce it at the beginning of this year. We have not gone very far yet and I cannot tell what the result will be. But we are requiring, of course, as are all Eastern States, that all devices shall conform to the Society specifications.

We have established adjustment stations throughout the State so that anybody who wishes to have head-lamps adjusted can do so. We are also issuing pamphlets explaining in detail the process of adjusting head-lamps.

I do not think that the focusing of head-lamps, especially the head-lamps that are coming out now, is a very difficult matter. It consists merely of taking a screw-driver, turning a screw until the beam is of the smallest width in a vertical direction, and then tilting the lamp down so that the beam comes below a cross-bar or mark placed on a door or wall. That does not seem to be complicated. If we can get everybody interested in head-lamps so that they will keep them down, we shall have accomplished something. More than that cannot be ex-

[17] M.S.A.E.—Technical director, Electrical Testing Laboratories, New York City.

[18] Director of headlight enforcement, Bureau of Motor Vehicles of the State of New York, Albany, N. Y.

pected. But after 75 or 80 per cent of the drivers have adjusted the lamps, we shall be able to judge whether the system is good.

Effect of Making Changes in Laws

At the present time, only three or four states are enforcing this law rigidly. It is my opinion that most of the statements that have been made here have been based on conditions in states in which there is no regulation, or practically none. We must wait a while to find out whether the present system will work before we decide to make changes.

Laws are based on some fundamental condition. In this State, the requirement is that the beam shall not be higher than 42 in. at a point 75 ft. in front of the car. If that is changed, it will mean changing the law, and that at least 5 years will elapse before any effect of the change will be obtained, as a law compelling drastic changes on a great number of cars cannot become effective overnight.

E. C. Crittenden[19]:—The public not only wishes to do away with glaring lights but has the unfortunate belief that some simple law can be passed which will accomplish this. In view of all the difficulties that Mr. Crane has pointed out, it appears that perhaps the best solution would be obtained by a very simple law, that is, a curfew law, requiring you to keep your car at home at night. But I do not believe that most of us would be willing to do this.

Another solution is the lighting of the highways independently of the lights on cars; that would be fine, but complete highway lighting is impracticable. Persons must drive on unlighted highways, they must furnish their own light on the road, and the problem is how to do so without excessive glare.

The results obtained in that direction have not been perfect. But, it seems to me, the industry takes a great risk if it begins to tinker with the present requirements without being sure that it is getting a definite improvement. What that improvement should be is evidently a matter on which difference of opinion exists, but, as has been indicated, one place for improvement is in the devices themselves, in their method of construction.

A difficulty I would like to point out is this. The states will not wait several years for a solution to be worked out. They want something now. This week a bill is before the legislature of the State of Illinois with provisions that will be troublesome if adopted, and if some authoritative requirement is not available that State and others will try various experiments with resulting expense and confusion for the motorist and the motor trade.

A difficulty that we have met at the Bureau of Standards is in having State officials ask for advice as to what regulations they should adopt. We have felt that the best we could do was to recommend the standard regulations, those approved by this Society and by the Illuminating Engineering Society covering approval of headlight devices. The adoption of these regulations must not, however, be considered as settling the question of headlights; it is only the first step. The second and more difficult one is that of securing a reasonable use of the devices after such a law has been passed. I feel rather pessimistic over the possibility of educating 17,000,000 or 18,000,000 drivers to keep their lights in adjustment; but that seems to be the only practicable avenue of improvement. These remarks should not be considered as making objection to a program of research. We ought to have research, but so far as this research bears on legal regulation we ought to keep it quiet until a real improvement in the regulations is ready to be presented to the public.

Mr. Crane:—In view of what Mr. Crittenden has said, I wish to say that the question of Government regulations has come up over and over again and the Society has taken the stand in a number of cases that it is entirely wrong to write detailed specifications of any kind into a legislative measure. I think that applies to headlight legislation. If any legislature wishes to enact that the specifications of illuminating engineering societies shall be the basis of legislation, that may be all right. But to take the regulations as they exist and write a law is a very short-sighted policy. The testimony is, that if it once gets in, no way of changing it exists; and everything indicates that the regulations have been changed two or three times since we began and that they will be in a state of flux from time to time. The last speaker has asked for a number of modifications. The trouble is that we are "up against it" when we want to make improvements that we all agree are very desirable.

W. W. Matthews[20]:—So far as I can see, the car builders are about the only persons that criticise the specifications. It looks as if part of their objection is caused by their difficulty in meeting them or their unwillingness to meet them, in many instances.

They talk about a campaign of education. We attempted to institute one in Pennsylvania last summer, and it gave good results. But the people came round after it was over and said,

> You have told us what to do and that if these devices meet the specifications we shall not have to worry about them. We put them on our cars, we get them adjusted and, in a few days, they are out of adjustment.

The principal trouble seems to be with the lighting equipment that is put on the cars, and, as one speaker said, the purchasing department seems to dictate the policy. I should like to see the engineering and sales departments dictate it. I know of no motor-car builder who has as yet featured the headlighting equipment of his car. Up to the present time, they are probably afraid to do so because they know the deficiencies, and because the problem of enforcement is thought to be very difficult. I do not know that it is particularly difficult. We are making good strides in Pennsylvania with it, but we have this continual throw-back from the public.

Motorists all want to know whether the devices that they have on the car will meet the law after they have been properly adjusted. When we tell them that they will meet the law and they find that the devices will not remain in adjustment, they begin to think that nobody knows what he is doing and, least of all, the authorities in charge at Harrisburg. A great part of the problem lies with the motor-car builders. In many cases, the lamp manufacturers are willing to do what they can, but are forced to comply with the penny-saving tactics and cheapened specifications of the car builders. A large part of our trouble in approving headlighting devices, particularly new devices submitted for consideration, is that the car builders try either to get around the requirements or to meet them in the cheapest possible manner.

[19] Chief of the electrical division, Bureau of Standards, City of Washington.

[20] Chief inspector of the Department of Highways, Commonwealth of Pennsylvania, Harrisburg, Pa.

The Engineer's Part in Increasing Highway Safety

By C. F. KETTERING[1]

SEMI-ANNUAL MEETING PAPER

ABSTRACT

MANY things have been done by the automotive engineer to promote safety on streets and highways, as proved by the fact that but from 2½ to 5 per cent of the accidents that occur have been caused by the vehicle itself. Very few instances can be cited of accident caused by failure of the parts of motor vehicles, the control of the metallurgy of the parts being so exact that it is a factor contributing largely toward increased safety.

Various other improvements in the design of motor vehicles that have contributed toward their safety are enumerated, one being the lowering of the center of gravity of the vehicle, a very important element of its safe control. It is pointed out, however, that not all makes have had their center of gravity lowered, and that the introduction of the closed body has tended to offset this improved condition. The advent of four-wheel brakes centered public attention on the subject of adequate braking, and great improvements in braking ability have since been made; but other developments are needed, such as enabling brakes to meet the requirements of their specifications for a longer period and the provision of better brake adjustment. Increasing the horsepower of the engine and providing better acceleration to afford ease of passing a vehicle to gain a position ahead are desirable from the standpoint of safety. Bumpers and other devices, such as the stop light, have been of great benefit, and so have the improvements made in steering-gears.

After pointing out that present methods of lighting motor vehicles are inadequate and unsatisfactory, and that the variety of state laws on the subject causes confusion, the author discusses the personal element in its relation to safe driving. Stating that even when all the possible controlling devices have been installed a vehicle is not a motor car until someone sits back of the steering-wheel, he says further that although the automotive engineer has tried to provide comfort, ease of operation and exact control, anything additional that can be done to enable control of the machine by instinct rather than by reason tends toward greater safety, because of the dazing effect of surprise due to emergency conditions and the lack of time a driver has in which to act.

Uniformity with regard to restrictions upon design would simplify the problems of designing engineers, since the vehicle must satisfy the commercial conditions of practically the entire world and the design must be a compromise that is a fair average of the requirements if maximum selling possibilities are attained. Therefore, a standardization of traffic regulations would tend to improve motor-vehicle design.

Considerations regarding theft, casualty and liability insurance are stated, locking-device locations and the use of locks are criticized constructively and the foolhardiness that causes drivers to race motor vehicles to pass grade-crossings ahead of railroad trains is deplored. If but two measures of traffic-regulation improvement were allowable, the author believes that maximum benefit would result from making definite designations of right-of-way streets and highways and the marking of cross-roads so that travelers on them are informed of the proximity of these rights-of-way.

THOSE who have not read the report of the First National Conference on Street and Highway Safety should get a copy and read it because it states the fundamentals of the work of increasing highway safety still to be accomplished. The question regarding what the automotive engineer has done toward increasing public safety on streets and highways is well answered by the fact that only from 2½ to 5 per cent of the accidents are caused by failures in the vehicle itself. It was not an uncommon thing years ago to have something happen to the steering-gear such as the occasional breakage of a steering-knuckle, but I believe that through the control of the metallurgy of the various parts entering into the construction of the motor vehicle today, failure is very largely eliminated. The good materials used, the work done by the Society in its standardization, the elimination of various kinds of unsuitable steel, and other improvements have contributed to such a great extent toward the reduction of troublesome and dangerous factors that a continuous improvement in motor vehicles has been made.

Some vehicle improvements have been directly responsible in helping to increase highway safety. First comes the lowering of the center of gravity of the car. But not all the cars have had their center of gravity lowered, and the introduction of the closed body has tended to offset some of the good work done in that direction. How much farther that trend can go I do not know, but it has been an important factor in the control of the vehicle.

With the advent of the four-wheel brake, public attention has been focused more particularly on the braking situation. Prior to 5 years ago, the brake was just a device for stopping the car, and had no great degree of precision. Within the last 5 years, much study has been expended upon braking and it is still far from finished, contrary to much publicity in some of the newspapers regarding brakes.

Various types of application and various designs of brake exist, but a few improvements still are needed. The coefficient of friction today can vary 100 per cent depending on whether the brakes are dry or wet. It is very difficult for anyone to estimate exactly when the car will stop. The automotive engineer has been conscientious in his work of designing brakes so as to meet certain deceleration factors, and I realize that in outlining what he ought to do I am stepping outside the bounds of my subject, but I think that not enough attention has been paid as to how long brakes meet the requirements that the engineer has specified. I think that if we selected at random 100 cars equipped with our most modern brakes, we would be greatly surprised to find that they are not up to the requirements set-up by the engineer.

Varied ideas prevail about the adjustment of brakes. Hardly a garage in the Country exists whose representatives have not some suggestion for a much better way of

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adjusting brakes than that prescribed by the engineers, and some day we will draft those practised people into the actual designing of motor cars. In our desire for better braking we have considered the matter too largely from a theoretical basis for a car as the engineer has designed it and perhaps as his factory has built it, but the subject of brakes today is much more important than it ever has been, and it should have more thought than we have ever given it. Congestion of traffic makes that absolutely necessary.

Increased Horsepower and Acceleration

Automotive engineers have been working to increase the horsepower and the acceleration of the car. While regarded by many people as being not the type of improvement that would increase safety, we believe that acceleration, as it has been worked out and is being further developed today, is very important from the safety standpoint. On any of the congested highways the length of time one has to pass a vehicle going in the same direction before another approaches from the opposite direction is usually very short, and thus acceleration is an important factor of safety. I believe that we have not yet gone the limit on what can be accomplished with increased acceleration. Much of the increase in power has not been with the idea of acceleration but rather a question of maximum speed, which we believe does not contribute to safety, and yet I doubt if any automotive engineer present has ever driven very far within the speed limits.

Rear-view mirrors have been of great assistance in increasing safety and requiring traffic policemen to wear uniforms has helped also. I believe that one traffic officer mounted on a nickel-plated motor-vehicle that could be seen at a distance of 3 miles would have more to do with the control of safety on the highways than would any speed trap. The fact that a driver knows the officer is on the road has a wonderful effect. Some signal system indicating that an officer is on the highway and an exceedingly generous fine if a driver is caught would help considerably.

I believe the accelerating ability of the motor vehicle is a fundamental of safety. I was very much impressed in this regard recently when I had occasion to drive a car some 250 miles over badly congested highways. Purely by accident, the car happened to have unusual accelerating-ability because it was equipped with a special gear-ratio for testing purposes. The car did not have a very high maximum-speed, yet I had few thrills when driving that car on a congested highway because of the ease with which I could pass a vehicle and thereby gain my position ahead.

Inadequate Brakes and Lights

The portion of the highway between Columbus, Ohio, and Cleveland and Mount Vernon to Akron has received the name of "Suicide Lane." I believe not five consecutive panels of the fence along this section of the road will be found which someone has not driven through, a fact that cannot be attributed wholly to motor vehicles. This part of the highway is not nearly as bad as many highways over the mountains in Pennsylvania, but it happens to be a piece of hilly highway in an otherwise level country. I think inadequate brake-control is responsible very largely for the numerous accidents, plus another difficulty over which the automotive engineer has absolutely no control. I refer to the attempt of one driver to pass another near the top of a hill. We had occasion on that trip to note the interesting fact that, three times within 20 miles, drivers had attempted to pass a car near the top of a hill, only to meet a car coming over the hill from the opposite direction. Good brakes and an alert driver on the approaching car are about the only things that prevent an accident in such instances. A driver in the car that is trying to pass one going in the same direction will spoil anything that the engineer can do.

The introduction of the stop light undoubtedly has been of great value in averting accidents in congested traffic and the various other signal devices that may be put on a motor car may be of equal value. But I think we all recognize that the automotive engineer has perhaps been delinquent in one phase of design, car lighting, and yet he can offer many legitimate excuses why he should have been delinquent in this respect. Our methods of motor-car lighting on the highway are inadequate and something must be done to make them better. Considering the great variety of laws in the Country that govern car lighting and the great number of specific ideas as to how lighting should be accomplished, the automotive engineer has done about all that he can do. Since the engineer is only representative of one type among a large number of types of people who are involved in the automotive industry, he has been forced to accept whatever would "get by" and cause the least trouble for the sales department. A commercial phase is involved in this matter beyond which the engineer has very little control and, if he did have control, the result perhaps would be in no wise favorable to himself.

I believe that we need and should demand the very best talent that we have on lighting. Once we get an interstate agreement on what lights should be and how they should be controlled, the automotive engineer can solve the problem and will be only too happy to do it. Ever since I have been associated with the automotive industry we have had a variety of State laws of one kind or another which have remained in force for a year or so and then have become inactive, so that today we have that perfectly uncontrollable factor which I believe is one of the worst hazards we incur, especially in night driving.

Ease and Adequacy of Control

Controllability is another factor that the automotive engineer has unconsciously worked into his design of motor cars. A vehicle is not a motor car until someone sits back of the steering-wheel; the car will go no place and has absolutely no controllability until a driver is put into the seat. Therefore, the automotive engineer has tried to give the driver comfort, ease of operation and adequate control, so that it is possible for him to control the vehicle sub-consciously to the greatest possible extent. The ease of reaching levers, the brake-lever position and items of that sort are all contributory to safety.

A fact that must be recognized in the design of any piece of apparatus, where questions of accident or of surprise are involved, is that nobody purposely arranges an accident. If anybody did so, it would not be an accident. We must also recognize that, where the element of surprise exists, very little reasoning power is available; in other words, under such circumstances, we always react on impulse, and we must accept that as a first principle. Those who have been in an automobile accident doubtless realized, after the accident was over, that they perhaps could have done better if they had only had time; but not very much time in which to act is available and we must meet the emergency as it exists. So, anything that can be done in the design of a motor car which makes the vehicle controllable by instinct rather than

by reason is of a most important nature because, in a situation that causes surprise, we do very little thinking.

The addition of bumpers to the motor car has increased safety in certain instances. Steering-gears have been improved. We do not know whether they are being improved now or not. I sometimes think we ought to have a handle on the modern steering-gear, like the one we used to have on the traction engine, so that we could wind it up. But steering-gear difficulties are not wholly the automobile engineer's fault; some of the difficulty has to be laid at the door of the balloon-tire expert. I think we will have to ask the balloon-tire manufacturers to develop a type of tire that will have considerable traction when the wheel is moving and none when it is standing, so that cars can be parked easily. No doubt the increasing of steering-gear ratios militates against good control of a car. In certain cars, the steering-system is not all that it should be, and yet the cost factor has a bearing on steering-gear design-changes, and that is an important consideration.

Many problems remain to be solved. We have a great volume of work to do in the furtherance of the work of safety so far as design is concerned. But it is very confusing to the engineer to be faced with a large number of different types of traffic restriction with which he must comply because, when he designs an automobile, it must meet the commercial conditions of practically the entire world, and he has to strike a mean that will permit the vehicle to be sold under any conditions, for nobody knows when that car is being assembled whether it will be used in this Country or overseas. Therefore, a standardization of traffic regulations would help the automotive engineer to simplify the problem and would open the road to a further improvement in automobile design.

It is interesting to note that the increase in accidents on the highways bears almost a direct ratio to the increase in the number of gallons of gasoline used. We have been increasing gasoline consumption at the rate of about 14 per cent per year and, according to the report of the National Conference on Street and Highway Safety, accidents have increased by about 14 per cent per year. This report states that we are killing people at the rate of about 22,600 per year and injuring very nearly 700,000 per year. That is one-third of the total American fatalities of the war and we are injuring two and one-half times as many people per year as were injured in the war. The difficulty of the situation is that we cannot place the blame on anyone, because so many factors are involved in safety. The engineer must, therefore, gather out of all the conditions those things that he can do.

I am sure that, if the accident situation were analyzed, it would be found that the steering and the controllability of the automobile constitute large factors in the accident rate. We must recognize also that the design of an automobile to run in a country having snow and ice differs from that of one to run in countries that do not have snow and ice. Discussion regarding this is always brought up every time we go abroad in connection with four-wheel brakes. The foreigner cannot understand why we do not put 50-50, or equal pressures, on our four-wheel brakes all the way through; and yet, as a rule, he never has any sleet and ice to deal with, and the conditions are different. Controllability has considerable to do with accidents. We have some cars in this Country in which the steering is not rigid, but the commercial phase is always coming up there and, because of the highly competitive way in which automobiles are sold today, the addition of extra cost to the motor vehicle becomes an important consideration.

Automobile Insurance

When automobile insurance became an important factor, we worked with the Underwriters' Laboratories as to the ratings of automobiles. If some way existed, in which we could rate the insurance of automobiles on their safety features, so far as controllability, brakes and other things are concerned, I think that would have considerable to do in clarifying the situation. As the situation is today, we can only take the records of the sales department and the service department as to the degree of safety that the automobile possesses and, if the automobile is unsafe and sales fall off, then changes are made. If we could get the casualty-insurance companies to make some rules as to insurance rates, especially on liability and property damage, that would help the automotive engineer. None of these things is difficult to do if one only knows what to do; in other words, if a car is giving satisfaction in the hands of the public, it is very undesirable, from the standpoint of the engineer, to make a change.

Lack of insurance rating-rules is a serious condition and one that should have the very careful consideration not only of our Society but of every society regarding this matter of safety. We are increasing the number of automobiles materially each year. We say we have not enough roadways and yet, when we consider the taxes necessary to increase our highways, that becomes also an important problem. Therefore, it seems to me that two factors, the commercial and the engineering considerations, must be worked-out together so that we can place the maximum number of automobiles on our present highways with the greatest degree of safety. When that is accomplished, if we get super-highways, such as are being built in the congested centers of the Country, we will have progressed just that much farther.

The automobile fire-hazard constituted one of the greatest obstacles for a long time, but automotive engineers overcame that and, through the cooperation of the insurance interests, it has been reduced greatly. Theft was a factor that entered into automobile insurance, and we have satisfied the insurance people on that subject. They insisted on having transmission locks provided, but they tell us frankly that more cars with transmission locks are stolen than is true of any other type of lock, for the simple reason that nobody uses them. From that I deduce that engineering would be very simple except for the people; in other words, if we could enforce a simple set of rules that required a certain kind of lock on a car and compelled the owner to lock it, that would be fine; but it costs a pair of gloves or a new pair of trousers or something like that to lock a transmission lock on some of our most modern automobiles and, therefore, they are not locked. So today it is being urged that we get rid of transmission locks and use some other kind of lock or no lock at all. I mention this for the purpose of illustrating that, when dealing with new situations such as we have today, we must try various methods. As engineers we have been forced to experiment with many means because we have to deal with different types of people. We must make a start providing a method for all this matter of highway safety that will develop organizations sufficiently alert so that, if a means proves unsatisfactory, it can be changed promptly. If people do what we want them to do, some specific means may work out well; but people seldom do that and, also, they do things that one would never expect;

therefore, they upset everything and we have to reorganize to meet the changed situation.

Defining Rights-of-Way

Suppose someone said, "There are just two things that you can do to increase highway safety; what are they?" I have thought considerably about public safety and have watched conditions in many places throughout the Country, and I believe that two things can be done to increase safety generally which will be more effective than anything else: First, to make definite designations of right-of-way streets and highways; second, to mark the cross-roads so that travelers on them are informed of these right-of-way streets and highways and made to understand that whoever goes onto them does so at his own risk. That would rid us of the side-street fool who runs out in front of traffic and is one of the greatest nuisances we have. It is to one's own interest as well as to the interest of everyone else to know that certain streets have right-of-way. I have seen that work out well in Chicago on Jackson Boulevard for many years when they had the "stop" streets, long before this question of safety was discussed.

Another very important aid, especially in towns that cannot afford an elaborate signal system such as is used in large cities, is the so-called "automatic policeman" to regulate traffic. No great amount of trouble exists in the centers of towns that have traffic regulations and signal systems. There, the problem is simple enough. Just outside of that zone, where no traffic regulations apply, is where drivers take a chance on cutting-in ahead of traffic and cause trouble. These automatic policemen are not very expensive, and a generous installation of them in cities of moderate size certainly would improve conditions. We must give credit to the people who have installed these flashing signals throughout the Country at railway crossings and street intersections, even though they be but advertisements. I hope that kind of advertising pays, because I realize that it is almost impossible for public officials to accomplish such installations, and I believe it has been conducive to safety.

Grade-Crossing Accidents

One thing that the automotive engineer cannot do is to rid the minds of drivers of the idea of racing with a train to reach a railroad grade-crossing which, in 1924, was one of the great causes of accidents. In the last year, traveling between New York City and Dayton, I have seen seven people killed by trains, in each case on perfectly open crossings having no obstructions to vision either way. Within less than ½ mile of our research laboratories at Dayton we have had five fatalities within the last year, entirely of the same nature, where people have driven in front of railroad trains or in front of interurban electric cars. I do not know how that danger can be overcome. The automotive engineer can do nothing, but I am perfectly willing to say to the public at large that, if the public will designate what it regards as improvements in the design of motor vehicles, it will meet an instant response from the automotive engineer.

THE DISCUSSION

Alfred Reeves[2]:—Observations made at the instigation of the National Automobile Chamber of Commerce indicate that one of the very helpful things automotive engineers can do is to provide an easier adjustment of car brakes. Where examinations have been made in the various cities as to whether car brakes were in proper adjustment, the drivers invariably said that the brakes are too difficult to adjust, and that they had not made the proper adjustment for this reason.

Another contributing factor in connection with accidents is over-insurance. If the insurance companies would see to it that those owners who had accidents paid a higher premium the next year on their cars, and that if they had frequent accidents they would not be allowed to insure at all, it would tend to make them much more careful. Probably the thing that would make drivers more cautious on the highways than anything else would be to prevent their having any insurance, particularly with regard to men of means. I will guarantee that drivers would be very careful to avoid accidents if that were done.

When the matter of compulsory liability-insurance was up in New York State a year or more ago and Nathan Straus and his committee were holding a meeting about it, Senator Lowden made the point that if everybody in New York City who owned an automobile were required to have liability insurance, so that they had practically no responsibility on themselves, the streets of New York City would be very much like a race track. I think, after all, that the human side of this subject is much more important than the mechanical side. It requires considerable education of drivers and, particularly, law enforcement.

We are building 31 miles of automobiles every day. The consequence is that the roads are becoming congested, and yet people are attempting to drive at the same rates of speed that they drove years ago. We need to reduce speed on congested roads and in residential districts and to provide better regulated highways so that reasonable speeds can be maintained. The matter of requiring officers to be in uniform is one that will contribute considerably toward safety. The difficulty has been that the average officer, instead of being on the main highway with his motorcycle as a deterring factor, is generally hidden up the street behind a tree, disguised in khaki and ready to rush down on the offending motorist after the crime has been committed. We said that to the Police Commissioner of New York City, and he very promptly ordered all the policemen in New York City who had motorcycles and were on the highways to wear blue uniforms, but I am sorry to say that not all the men stay on the highways as they should.

There are 250,000 railroad grade-crossings in the Country. I think it might help very materially if the warning signal, instead of being 20 to 30 ft. from the crossing, where they were placed in the days when horse-drawn vehicles were going across, were placed some distance up the road and possibly with some other warning signal that would indicate to the motorist that he should slow down. Probably that would be costly, but the railroads are spending a great sum of money in trying to eliminate grade-crossings.

The Chamber has been conducting a series of contests among the school children of the Country. As a result, an average of some 500,000 essays per year have been contributed by the children. The first prize is a trip to the City of Washington with all expenses paid, and three of the children have an opportunity to get a gold watch. Some 500 prizes are given. It is interesting to note that in those localities where prizes are won by the children and that fact is published in the newspapers, a substantial falling-off in accidents is apparent during the following year in that territory. In the year following the time that the winner came from San Diego, Cal., they

[2] M.S.A.E.—General manager, National Automobile Chamber of Commerce, Inc., New York City.

did not have a solitary fatality there. My thought is that education and law enforcement will help more than anything else.

W. G. WALL[3]:—What we need is some good specific cures, but such are very few and far between. We have heard a great number of statistics, but what good do statistics do us? Is it not just as important to us that 1 person be not killed as that 100,000 be not killed, especially if that individual is some friend or some relation or a child of our own? We are just as much interested in keeping that 1 individual from being killed by an automobile as in keeping 100,000 from being killed.

Highway safety is divided into three factors, aside from that of the personal equation of the driver: First, the automobile itself, which is up to the automotive engineer; second, regulations and factors of safety, which are up to the municipal, state and national authorities; and third, education. The automotive engineer has done about all that is possible to make the motor car safe. Comparing the motor car with the locomotive is of no use. From childhood, we are cautioned to keep off railroad tracks, and railroad trains possibly never run much closer than 10 min. apart. Automobiles often run 5 sec. apart. The locomotive running at 20 m.p.h. will stop, possibly, in from 200 to 300 ft. The automobile running at that speed stops in 6 ft. with four-wheel brakes.

Although the automotive engineer has done just about all that can be done to increase safety, we do not mean to say that he has reached the limit, because each year he adds some factor of safety to his creation; but safety is largely a matter of education of the public and one that is also up to municipal and state authorities. For instance, if you are driving along a dark road on a dark night, how can you see a person in a dark suit walking on the highway? It is absolutely impossible, even if you have the very best of lights. Some states already have passed regulations that all individuals should walk on the left side of the road, opposing the oncoming highway traffic; but suppose, for instance, that we made the side of the road white, as some states have done, so that any object along the road would be made plainly visible by our ordinary automobile lights; that would be a help.

The automobile is made for speed, and yet all we hear is that we must keep the speed down. Having motor cars is of no use unless we can have a certain amount of speed. That is progressive. We know eventually that we will have the speed, and still we are regulated and supposed to keep the motor car down to very slow speeds on account of the factor of highway safety. It seems to me that we should provide thoroughfares, in our cities especially, that would allow through traffic to go at high speed. For example, one way would be to utilize the space occupied by alleys in some cities. We have alleys in Indianapolis and two or three of them each way, east and west or north and south, could very easily be made into thoroughfares by elevating them if necessary on which the speed of the car would not need to be limited; that is, within ordinary limits, such as 40 or 50 m.p.h. On the ordinary streets and side streets speed could be limited. I believe that a street system of this kind will do more toward increasing safety than will any of our standard regulations.

[3] M.S.A.E.—Consulting engineer, Indianapolis.

WORLD INTERNATIONAL TRADE

THAT the world will reach par again in the value of international foreign trade in the first few months of the coming year is the encouraging estimate presented by a study of trade figures for the past fiscal year made by the National Foreign Trade Council. The 15 principal exporting nations of the world, including the United States, which carry on more than 80 per cent of the world's export trade, showed a combined total of exports at the end of the fiscal year of 1924-1925 of about $15,088,000,000. Comparing the present exports of these countries with their exports in 1913, which amounted to $15,800,000,000, their proportionate recovery is thus within 5 per cent of their 1913 volume of trade. Excluding the United States, which has made a 30-per cent advance during the period in real trade, their present deficit is about 11 per cent from their standing in 1913. These figures allow for all deflation and are reduced to 1913 values. In other words, the parity now being approached is not one in dollar values, which have already passed 1913 figures, but in bread-and-meat and clothing values adjusted to cost-of-living quotations.

The volume of world trade will have reached or passed its 1913 figures by the end of the present year. The United States is accountable for most of this gain. Other countries that have exceeded the proportionate gain of the United States in the period have been Canada, with a gain of over 90 per cent; Japan, with a gain of 64 per cent; and Australia, with a gain of 35 per cent. The absolute amount of the gain recorded by the United States, over $800,000,000, is far in excess of that of any other nation when reduced to 1913 values. The gain of Japan has been about $203,000,000; that of Canada, $335,000,000; and that of Australia, $120,000,000. The most interesting gain of all has been that of France, which stands third among the nations, or next following the United States and Canada, in the amount of real trade gained since the war. France increased its exports from $1,328,000,000 in 1913 to $1,650,000,000 at the end of the present fiscal year, a gain of $322,000,000, or about 25 per cent.

In almost every phase of this comparison the United Kingdom rises or falls as the world rises or falls. Thus, the British deficit in export trade at the end of the fiscal year of 5½ per cent is almost exactly equal to the same deficit of the world at large. British export trade is growing at a rate of 9.0 per cent, while world export trade is growing at the rate of about 10.0 per cent; and the proportion that Great Britain now holds in the trade of the world, which was 14.2 per cent in 1913, is about 15.0 per cent today.

The United States export trade is now increasing by 13 per cent a year, or at a steadily larger rate than that of the rest of the world. The share of the United States in the aggregate trade of the world has grown from 13½ per cent in 1913, when it was less than that of Great Britain, to more than 18 per cent at the present time.

In spite of the fact that China's recent losses in trade have diverted attention from that country, it is interesting to note that China's latest export figures still show an actual gain over 1913 of 37 per cent, with an aggregate surplus for 1924 of over $100,000,000 greater than that for 1913. The preliminary estimates for the present year, however, show that disturbed conditions in China are materially reducing that surplus.—O. K. Davis in *Economic World*.

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The Motorcoach and the Railroad

By H. F. FRITCH[1]

AUTOMOTIVE TRANSPORTATION MEETING PAPER *Illustrated with* DRAWING AND PHOTOGRAPHS

ABSTRACT

MOTOR vehicles have become an important factor in the affairs of the railroads. In 1920, which was the peak year, the total number of passengers carried by the railroads of the Country was approximately 1,269,913,000, while in 1924 the number was approximately 931,348,000, a decrease of 27 per cent. This decrease was not entirely due to the private automobile but to some extent to the motorcoach.

The particularly acute situation is that branch-line revenues have been so depleted by the automobile and the motor truck that the main lines can no longer support these branch lines and more economical transportation must be found. The substitution of motor-vehicle service in such instances for steam-train service rather than the abandonment of all service will be to the advantage of the railroad, since it will make possible the continuance and probable increase of the industrial and social activities of the communities served by the branch lines so that they will not be lost as feeders to the main lines.

In an effort to solve this problem in the territory that is served by the Boston & Maine Railroad, a subsidiary, the Boston & Maine Transportation Co., was organized. Since last May this company has inaugurated a number of services of various types. These include motorcoach service at Portsmouth, N. H., as a substitute for the electric street railway that was discontinued; the substitution of motorcoach service for steam on a 12-mile line between Portsmouth and York Beach, Me.; an interstate line between Boston and Portland, Me., and the use of motorcoaches in the summer resort districts of New Hampshire to supplement steam-train service. At the height of the summer season eight distinct motorcoach services covering 445 miles were in operation. All of these various services and the results obtained are described in the paper. A fleet of 30 motorcoaches of two distinct types were used for these various services, 18 being of the so-called street-car type and 12 of the parlor-car type. In practically all of these motorcoaches double-depth individual cushions are used. Both types of motorcoach are described and illustrations of both the interiors and the exteriors supplement the text.

The paper discusses the possibilities of standardizing motorcoach design and the point is emphasized that the greatest demand for variation from standard practice is in the construction of the body rather than in the chassis. Among the other points touched upon are the use of proper springs, the improvement of brakes as regards effectiveness, the necessity for providing sufficient aisle and seating space, the selection of outside body sheathing and painting.

THE history of transportation is one of continual change with the fitting of new agencies of transportation into their proper relations one with another. This will probably always continue to be the condition as new scientific discoveries are made opening up new possibilities for engineers to develop more perfect and efficient means of applying power to the movement of persons and goods.

In the practical application of such developments two important tendencies are brought into play; first, human reluctance to change and, second, the disposition once having adopted a new idea to carry it to an extreme. The ideal situation is to steer a properly charted course between these two extremes so as not to retard progress, but on the other hand not to embark unwisely on ventures that will result in destruction and waste of capital. The tremendous capital invested in organized transportation agencies in modern times has made the utilities somewhat cautious about venturing into new and untried methods of transportation.

Just because a development is new it is not necessarily sound. The cable car at one time appeared to have a future but its life, except for special applications, was short. Only a few years ago we saw our cities overrun with the "jitney," and many would have said it was a permanent institution in transportation. Its life, however, in most places was short and it has now almost ceased to exist. It was just one step in the development of the motorcoach.

THE PLACE OF THE RAILROAD

The American railroad has been a remarkable development from the 30,600 miles of line in 1860 to the present 260,000 miles. It is particularly an American institution, over one-third of the total mileage of the world being in this country.

The railroad plays an important part in the economic history of the country, even to the extent that too-rapid railroad expansion has embarrassed the business structure of the country as in 1873, and in more recent years absence at times of facilities to cope with heavy demands have been harmful. Present good service and facilities are doing their part toward the general prosperity.

The investment in railroads is about $18,900,000,000, which is only slightly less than the investment in all manufacturing industries in the country. The passenger revenue in 1924 was $1,076,000,000, and the number of passengers carried 931,348,000.

The motor vehicle has become an important factor in the affairs of the railroad as it has in the affairs of practically all individuals and organizations. The volume of passenger traffic on railroads as a whole shows a decrease in recent years which I believe can largely be attributed to the competition of the private automobile. In 1920, the peak year and a very active industrial year, the total number of passengers carried was 1,269,913,000, while in 1924 the number was 931,348,000, a decrease of 27 per cent. Between 1923 and 1924 the decrease was 5.5 per cent. These decreases are not entirely due to the individual car, but to some extent to the motorcoach, although up to the last year or two the inroads made by the latter were relatively unimportant.

THE EFFECT OF THE AUTOMOBILE ON RAILROAD EARNINGS

The private automobile has had the most serious effect on railroad passenger-earnings in the pleasure-riding class. Such business was ordinarily handled at full fare or at slightly reduced excursion rates, which makes the

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loss serious. In this particular field it will be very difficult for the railroad to recover any large part of the business.

In the commuting district the private automobile has taken a certain part of the revenue, but as the railroads increase off-peak service through the use of unit rail-cars, and as city congestion increases it seems likely that at least a certain part of this revenue will revert to the railroads.

One of the places where the railroad has been hardest hit is in the sparsely settled territory where train service at the best has been infrequent, and with depleted revenue has become still less frequent. Coincident with this the public has become educated to the convenience of the automobile. Especially have they become obsessed with the idea that a conveyance must be at their disposal at the particular time they desire to travel. In other words, the idea of personal service in transportation has become important and the necessary waits for larger transportation units have become more of an irritation than formerly. The result is that as the automobile has depleted railroad earnings, resulting in a decrease in service, this decrease in service has further influenced additional travelers to use the automobile, further curtailing railroad revenues.

The railroads must study the effect of the automobile upon the public attitude toward transportation with great thoroughness to determine what changes they must make in their methods of doing business to make their service of the greatest possible benefit to the public and retain within their control all revenue that can be so retained economically.

The use of the automobile has made it possible for the individual to go and come more as suits his convenience than is possible when confined to train schedules. The automobile affords quicker transportation over the shorter distances where the rail lines may not be direct or the terminals not conveniently located. Automotive engineers have developed the product of their industry with a view to promoting a sense of personal luxury in travel, and of course, traveling by automobile possesses the element of privacy. Our modern-surfaced highways and the gasoline engine without smoke or cinders make clean travel possible at all seasons of the year. The 15,500,000 passenger automobiles in service are educating the public to expect these characteristics in transportation. On the other hand, the extent to which the automobile is being used clearly demonstrates that the public is willing to pay for the kind of service it wants. The great part of passenger miles by automobile certainly costs more than it would have cost by railroad.

Another effect of the private automobile is that railroad stations are rendered more accessible, which makes it possible to reduce the number of stopping places for long-distance trains. This increases the speed with which long-distance trips can be made and provides a more comfortable trip for the long-distance traveler by lessening the annoyance of stops. The railroads can profit much by studying these features of automobile travel and meeting them in so far as possible by improvements in rail service and by providing a coordinated highway service.

The Problem of the Branch Line

The particularly acute situation in so far as some railroads are concerned is that the branch-line revenues have been so depleted by the private automobile and the motor truck that the main lines can no longer support them, and means must be found to furnish transportation along the branch lines in a more economical way. The Boston & Maine Railroad believes that this can be done effectively and economically by using the motorcoach and motor truck. The substitution of motor-vehicle service in such instances for rail service rather than the complete abandonment of all service with no substitution will be to the advantage of the railroad in that it will make possible the continuance of the industrial and social activity of the community served by the branch lines and, we believe, probably increase their activity. This means that these communities will not be lost as feeders to the main lines but will become even more valuable in that respect than in the past. The matter of branch lines is by no means trivial for many railroads. In the case of the Boston & Maine 1024 miles of its line, or 42.0 per cent of the total, produces only 2.8 per cent of the total freight revenue. This is truly not a condition that would be allowed to continue in any private industrial enterprise.

In facing the branch-line problem it must be recognized that times have changed since these roads were built. Many of them were constructed for competitive purposes which reason for existence has long since disappeared as the result of consolidations. Many of them have been unprofitable from the day they were built and are even more so today with their depleted earnings. The advent of the motor vehicle has made possible service to these sparsely settled communities in a more economical form. The railroad cannot ignore this situation and will do well to recognize it and avail itself of this agency now at its disposal.

Operation of Rail and Motor-Vehicle Service

As I see the future of the railroad, it is to operate a main-line rail-service with properly organized motor-vehicle service as an auxiliary acting as a feeder into the territory where rail service can no longer be justified. This motor-vehicle service will include both the truck and the motorcoach. My discussion here will be confined to the use of the latter.

I believe the railroads owe it to the public that they serve to use the motorcoach in conjunction with, or as a substitute for, train service wherever sound economics justify it. The determination of the proper field of activity is not as simple as it sounds, and unless good judgment is used extravagant operations are likely to result on the one hand or ruinous competition on the other. The tendency is great to inaugurate competing motorcoach service in such a way as to take away from the rail line a substantial portion of the full-fare passengers, leaving for the rail carrier the low-rate commuter-travel. This makes possible only a very slight reduction in operating expense for the rail carrier, not at all in proportion to the reduction in its gross earnings. The result is that transportation for the communities concerned is being provided in a very inefficient manner. In the long run the traveling public will pay for such inefficiency, but it is difficult to make the general public see what an effect such an uneconomic arrangement will have. The fact is, however, that any territory should have a financially strong railroad serving it, with both passenger and freight service. Any condition that tends to weaken the railroad reacts in the long run through higher rates and poorer service.

Feeling that it should make every proper use of the motor vehicle, the Boston & Maine Railroad has organized an automotive auxiliary known as the Boston & Maine Transportation Co., which was formed under the laws of Massachusetts. This company is carrying on

certain motor-truck activities in the nature of store-door delivery and road haul, which, however, will not be discussed here. With respect to the use of the motorcoach, it is the intention to use it to replace train service where it can perform the service more economically, as a supplement to rail service between trains, as a feeder to rail lines from new territory, as a feeder along main lines serving local stops, and as a touring service to care for pleasure travel that desires to go over the highways.

The first motor installation was in the fall of 1924 before the organization of the Transportation Company. A short branch-line had operated with steam-passenger service at a loss for a long time. This steam service was replaced by unit-gasoline rail-car service that reduced the loss materially but that was still carried on at a substantial loss. Later the unit car was replaced by a motorcoach on the highway and the frequency of service materially increased. This service is still performed at some

FIG. 1—TERRITORY SERVED BY THE BOSTON & MAINE RAILROAD AND THE BOSTON & MAINE TRANSPORTATION CO.
The Motorcoach Service of the Latter Organization Vary from the Substitution of Motor Vehicles for the Electric Street Railway in Portsmouth, N. H., to the Operation of a 110-Mile Interstate Route Between Boston and Portland, Me., and Two Motorcoach Routes in New Hampshire To Amplify the Steam-Train Schedule. Last Summer Eight Different Services Covering 445 Miles Were in Operation

FIG. 2—THE MOTORCOACH AS A FEEDER TO THE RAILROAD
The Motorcoach Shown Is of the So-Called Street-Car Type That Is Primarily Used for Short Hauls Although in Emergencies They Have Given Very Satisfactory Service on the Longer Routes

loss, because of the scanty patronage available, but of much less magnitude than heretofore.

Since last May the Transportation Company has inaugurated a number of services to try out the application of the above mentioned theories. The territory served by the railroad and the motorcoach routes is shown in Fig. 1, and Fig. 2 is an illustration of a typical station in the territories served by the motorcoaches. Various installations will be mentioned, not for the purpose of describing particular localities and conditions in detail, but more for the purpose of calling attention to the essential features of the various types of operation and in so far as possible, in view of the short period of operation, to give some idea of the results.

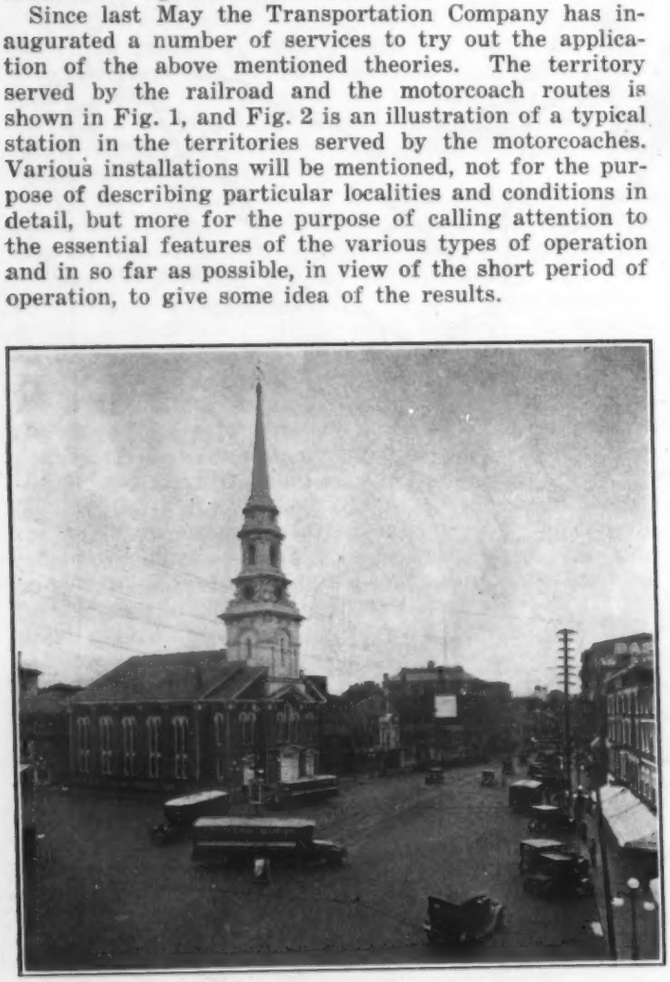

FIG. 3—VIEW IN PORTSMOUTH, N. H.
A Small Street-Railway System Was Formerly Operated by the Boston & Maine Railroad in This City. To Continue Operation a Substantial Amount Was Needed for Maintenance and Previous Operating Results Demonstrated That Such an Expenditure Was Not Warranted. As the Community Served Was Sufficiently Large Apparently To Warrant Some Form of Public Transportation, Motorcoach Service Serving Substantially the Same Territory as the Street Railway Was Substituted

MOTORCOACH OPERATIONS AT PORTSMOUTH, N. H.

The Boston & Maine Railroad formerly operated a small street-railway system in Portsmouth, N. H., which had reached a condition where substantial maintenance expenses were inevitable if operations were to be continued. Previous operating results clearly demonstrated that rehabilitation was not warranted. On the other hand, the community served was sufficiently large apparently to warrant some form of public transportation. Electric car service was discontinued and motorcoach service substituted, serving substantially the same territory. Views showing the center of the city and the motorcoaches receiving passengers are reproduced in Figs. 3 and 4.

Expenses for the first 5 months of operation indicate that this service can be operated in such a manner as to earn its full cost of service. The motor-vehicle service is in every way superior to the electric-railway service that it replaced, and the charges to the public are the same. On account of the flexibility of the motor vehicle it has been possible to try out new routes in territory not heretofore served. In addition a substantial chartered motorcoach service has been built up which is greatly appreciated by the community and of financial benefit to the Transportation Company.

A 12-mile steam railroad extends from Portsmouth, N. H., to York Beach, Me., on which in the winter season two steam-trains were operated in each direction daily and in the summer four trains. This operation has been unprofitable and at the beginning of the last summer season motorcoach service was substituted with 12 trips in place of the 4 steam trips, and more recently on the fall schedule 4 trips in place of the customary 2 steam trips. Not only did this route replace the steam service, but an extension of 12 miles was made along the shore with a tie-in on the other end with main-line railroad service. The station at one end of this line is shown in Fig. 5. This extension of service was in a territory not heretofore served by the steam road.

This service was very satisfactory to the community and produced a revenue much in excess of that from the former steam service. In the summer season the revenue was substantially in excess of the cost of the service. Whether or not this condition will apply on a full annual basis is yet to be determined by experience.

The two previously described operations considered jointly produced an interesting result with respect to earnings. Prior to the summer period and the beginning of the operation of the York Beach service the motorcoach service substituted for the Portsmouth electric lines showed an increase in earnings over the street railway earnings of the previous year. Included in the street railway and substitute motorcoach operation was a beach route. The beach was not conveniently served on account of the necessity of changing from the vehicle of one company to that of another. As soon as the York Beach motorcoach line was started with more frequent service than was formerly operated by steam the earnings on the Portsmouth group of routes fell off compared with the previous year on account of the beach travel shifting to York Beach with its much more frequent service. This was a very gratifying demonstration of the public's appreciation of improved service.

MOTORCOACH SERVICE BETWEEN BOSTON AND PORTLAND AND TO SUMMER RESORTS

A third motorcoach installation was made on an interstate run of 110 miles between Boston and Portland. This operation, in direct competition with the company's

FIG. 4—THE MOTORCOACHES RECEIVING PASSENGERS AT PORTSMOUTH, N. H.
The First 5 Months of Operation Indicated that the Motorcoach Service Can Be Operated So As To Earn Its Full Cost of Service. The Motor-Vehicle Service Is Superior in Every Way to the Electric-Railway Service That Is Replaced at the Same Charge to the Public and the Flexibility of the Motorcoach Has Made It Possible To Establish New Routes in Territory not Heretofore Served

own steam railroad service, was established largely because three other motorcoach lines were already operating in competition. The railroad company's motorcoach line charged substantially the same fare as the railroad, while the others operated on a cut rate after the railroad's line appeared. The secondary purpose of this operation was to get first-hand information as to the desires of the traveling public and the effect of the motorcoach on railroad travel. A large number of passengers have been carried, at times as many as four motorcoaches being required for one scheduled trip.

To get accurate information as to the reasons for passengers using such service, for a period the travelers were asked to fill out questionnaires. Replies showed that 87 per cent were traveling on pleasure and that 77 per cent of the total would have traveled by train if the motorcoach service had not been available. This is truly an astonishing condition in view of the common claim that such service promotes a large volume of new business.

At the present time there is an entire absence of law regulating such interstate operations. It is of vital importance that suitable law be enacted by Congress so that such operations may be limited to those which designated regulatory-bodies shall find are required for public convenience and necessity.

A fourth type of operation is that in which motorcoaches have been used to amplify a steam-train schedule. The Boston & Maine serves a wonderful summer resort territory with beaches, lakes and mountains in Massachusetts, Maine, New Hampshire and Vermont, as can be seen from the map reproduced in Fig. 1. Not so many years ago these places were reached only by train service, but with the advent of the automobile and improved roads the railroad traffic has suffered and it has been necessary to curtail the service. Such a curtailment, however, has a tendency to drive others to the use of the automobile and to detract from the popularity of the resort, both of which are to the disadvantage of the railroad. To meet this situation with two lines in New Hampshire, one 29 miles in length and the other 42 miles, two motorcoach trips in each direction were put on during the summer season in addition to two trains. The motorcoach trips made main-line train-connections in part formerly made by train trips. In addition they made available some train connections that had not been provided at all in recent years. This service met with much approval, but during the short period of operation last summer it was not entirely self-supporting. Probably in another summer period with more advance information to the public financial results may be more satisfactory.

The supervision and maintenance of these operations is by an organization entirely separate from the railroad

FIG. 5—THE MOTORCOACH AS A SUBSTITUTE FOR STEAM-TRAIN SERVICE
At the Beginning of the Last Summer Season Motorcoach Service Was Installed on the 12-Mile Run Between Portsmouth, N. H., and York Beach, Me., 12 Trips Being Made Daily in Each Direction as Compared with Four Train Trips. A 12-Mile Extension Was Made along the Shore with a Tie-In at the Far End with Main-Line Railroad Service, This Extension Being through a Territory Not Heretofore Served by the Steam Road

FIG. 6—ONE OF THE STREET-CAR TYPE OF MOTORCOACH USED
The Motorcoach Shown Is One of Three That Is Mounted on a Standard Light Six-Cylinder Chassis and Has a Seating Capacity of 21

operating organization except that on some of the isolated routes railroad trainmasters and agents supervise the operation. However, as far as the public is concerned, every effort has been made to adjust the motorcoach service to function in harmony with the train service. Schedules of this service are given a place in the general time-table of the railroad and advertised generously about the railroad stations. Reservations for the long-distance motorcoach routes are being handled in the railroad Travel Bureau. In the summer the Boston-Portland route was given the feature place in the railroad time-table. At the same time some marked improvements have been made in train service on this route by adding new trains and reducing running time, which have also proved popular.

At the height of the summer season eight distinct services covering 445 miles of route were in operation daily. For this service a fleet of 30 vehicles of two types was used, 18 of the so-called street-car type, and 12 of the parlor-car type. In selecting the motorcoach to be used the desirability of taking as nearly as possible a standard product was kept constantly in mind, believing that standardization is important if the production of motorcoaches is to be put upon an efficient basis.

THE STREET-CAR TYPE OF MOTORCOACH

For the street-car type one of the standard four-cylinder chassis was used for 14 of the 17 and a standard light six-cylinder chassis for 3 others. The bodies on these two chassis are practically identical except for length. The seating capacity of the body mounted on the light-weight chassis, shown in Fig. 6, is 21. The seating capacity on the four-cylinder chassis is 25 in the case of 4 vehicles and 29 in the case of 10. This type of coach is illustrated in Fig. 7. The general appearance and dimensions, except for length, are identical and the general type of construction is substantially the manufacturer's standard. These units are used in places where the average ride is relatively short and the interchange of passengers somewhat frequent.

In certain instances these motorcoaches are required to carry baggage, and part of the units have a door 32 in. wide on each side at the rear and the rear bank of seats is replaced by five seats that can be tipped up against the back when not in use, affording a clear space for baggage. The floor is neatly bound with iron and the windows protected by bars, as shown in Fig. 8, so that it is perfectly practicable to carry trunks.

In selecting this equipment the characteristics of the service in which they were to be used were kept constantly in mind and the various dimensions of the unit

FIG. 8—BAGGAGE CARRYING ARRANGEMENT IN THE STREET-CAR TYPE OF MOTORCOACH
To Enable These Motorcoaches to Carry Baggage When Necessary a Door 32-In. Wide Is Located at the Rear of Each Side and the Rear Bank of Seats Is Replaced by Five Seats That Can Be Tipped-Up against the Back of the Vehicle When not in Use. The Floor is Bound with Iron and the Windows Are Protected by Bars, Thus Making It Perfectly Practicable To Carry Trunks in the Clear Space Thus Provided

FIG. 7—ANOTHER OF THE STREET-CAR TYPE OF MOTORCOACH
This Vehicle Has a Standard Four-Cylinder Chassis. Of the 14 Vehicles of This Type in Service 4 Have a Seating Capacity of 25 and 10 Will Accommodate 29 Passengers. Both This Motorcoach and That Illustrated in Fig. 6 Are Identical in General Appearance and Dimensions, Except for Length, and the General Type of Construction Is Substantially the Manufacturer's Standard. These Units Are Used in Places Where the Average Route Is Relatively Short and the Interchange of Passengers, Somewhat Frequent

were made consistent with these uses. The seats selected are substantially more comfortable than those provided ordinarily in the street-car type of motorcoach because of the feeling that a soft seat with adequate springs is desirable, at least in all but the very shortest of city runs. The seat spacing is arranged to give adequate knee-room and the width is generous. Aisle width is somewhat less than would probably be desirable in coaches for strictly city service, but it is sufficient to allow passengers to move in and out without unreasonable crowding. The older vehicles of this type have

seats with one single-depth double-width cushion. Later deliveries are provided with double-depth individual cushions of the general type ordinarily used in parlor-car type of motorcoach. The principal dimensions with respect to seats in the latest vehicles are as follows: Seat spacing 31 in., seat width at cushion 32½ in., aisle width at cushion 12 in., and the backs are rounded so that at the hip line the clear space is 19 in.

The street-car type of body has ample head-room for most people to stand upright in comfort, having 73½ in.

FIG. 9—INTERIOR OF THE STREET-CAR TYPE OF MOTORCOACH
The Earlier Vehicles of This Type Were Provided With Seats Having One Single-Depth Double-Width Cushion. Later Deliveries Are Equipped with Double-Depth Individual Cushions as Shown. Ample Aisle-Space and Head-Room Are Provided. The Seats Are Finished in Leather, the Floors Are Covered with Linoleum, Wood Finish Is Used Rather than Fabric and the Lighting Fixtures Are of a Durable but Ornamental Character

in the clear under the car lines with 75 in. to the roof. The outside over-all width is 94 in.

The inside finish of these motorcoaches has been given considerable attention to make them attractive. In doing this no attempt has been made to equip them with unnecessary frills, but plain finish of good quality has been the practice with the feeling that in the long run such construction has the most appeal to the public. All the seats are finished in leather, floors are covered with linoleum, and wood finish used rather than fabric. The lighting fixtures are of a durable but ornamental character. The interior of one of these motorcoaches is illustrated in Fig. 9. While these vehicles were designed primarily for short-haul work, they have been used in emergency on long hauls with entire satisfaction to the passengers on account of the comfort of the seats and the attractive finish.

For the exterior colors were selected which would be striking and attractive, not flashy, and at the same time practical from a maintenance point of view. The main body color is a medium green with a cream belt-rail. The roof is a light green. This color combination has the additional advantage of being readily visible at night.

THE LONG-DISTANCE MOTORCOACH

For the long-distance work a standard chassis with a six-cylinder engine was selected. A standard body made by the same manufacturer was also chosen. This unit, as can be seen from Fig. 10, is distinctly of the parlor-car type with low head-room, recognizing that no standing passengers would be carried. This body is ordinarily equipped for 25 or 29 passengers, depending upon whether or not inside baggage-space is provided, but for this operation the seating capacity was cut down to 20 to provide the greatest practical seat comfort for every passenger. Instead of using the conventional arrangement of two seats on each side of the aisle, two seats were placed on one side and one on the other, as shown in Fig. 11. With this arrangement a double seat has a width of 38½ in. inside the arms, and the single seat 19 in. The seats are so arranged as to have no seat over the wheel housing, the aim being to have every seat a comfortable one. Some baggage space is provided inside, but most of it is carried on the roof.

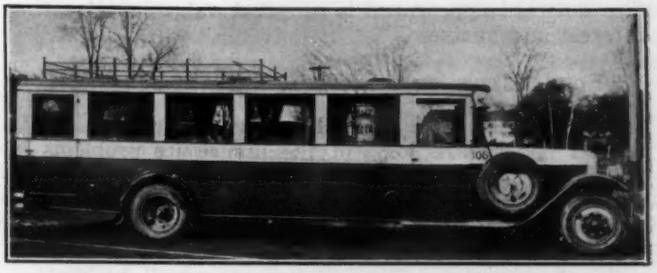

FIG. 10—THE PARLOR-CAR TYPE OF MOTORCOACH
This Vehicle Has a Standard Chassis With a Six-Cylinder Engine and the Builder's Standard Body. These Motorcoaches Are Used on the Long-Distance Run between Boston and Portland, Me., and on Two Routes, One of 29 Miles and the Other of 42 Miles, in the Summer Resort Territory of New Hampshire

As in the case of the street-car type, the inside finish was selected with the idea of having a plain, rich and durable finish rather than a highly decorative finish that would have too great a tendency to become shabby. Experience has shown that this policy was justified, and also that the most satisfactory baggage-space is inside the body rather than on the roof.

The outside finish of these motorcoaches is somewhat more decorative than the street-car type, which is in keeping with their character. Below the belt rail they are finished in a light green, and from the belt rail to the roof in cream. Our experience has shown that attrac-

FIG. 11—INTERIOR OF THE PARLOR-CAR TYPE OF MOTORCOACH
Instead of Using the Conventional Arrangement of Two Seats on Each Side of the Aisle, Two Seats Are Placed on One Side and One on the Other. This Arrangement Gives a Width of 38½ In. Inside of the Arms for a Double Seat and 19 In. for a Single Seat. The Seats Are Arranged So as Not To Have One Over the Wheel Housing. Some Baggage Space Is Provided Inside the Vehicle but Most of the Luggage Is Carried on the Roof

tive outward appearance is of great value in attracting interest and business.

Possibilities of Motorcoach Standardization

I would now like to make some observation as to what I believe are some of the immediate problems in motorcoach design and what may be done with reference to standardization. It is not the purpose of this paper to discuss city types of motorcoaches, but rather those types that would ordinarily be used in conjunction with railroad operation. These latter may well be divided into two classes, first, those to be used for operation in suburban and country territory for transportation of passengers for short or medium hauls, usually at moderate speeds, and, second, those to be used in long-haul interurban runs at touring speeds.

We must have in mind that a very large part of the public today is accustomed to automobile travel and expects a considerable degree of comfort and smooth running in any motor vehicle. Observation has led me to believe that this same public expects from a large handsome appearing motorcoach a much superior degree of comfort and smooth running than from the ordinary automobile and becomes very critical if disappointed. Much progress toward meeting this point of view has been made in the last few years, but much is yet to be done.

As the motorcoach developed from the motor truck and bodies were all custom made, it was natural for the operator to insist on variations from the manufacturers' standards in truck-chassis design and for a weird collection of bodies to have been produced. This was a natural transition period, but now that it has passed we should profit by it and make every reasonable effort as between the operator and manufacturer to work to standard design. I feel that the percentage of construction which is standard can be much increased without injury to the operator.

Probably more trouble is experienced from desires on the part of the operators to depart from standard body design than from chassis design. This is somewhat the chassis builder's fault as too often the operator after acquiring a chassis has been turned loose to purchase a body on his own responsibility. This has tended to retard the development of standard bodies. This separation of chassis and body building has also made the chassis builder less responsive to changes in designs that the body builder has found necessary to meet concerted demands on the part of the operators than with a closer relation between the two producers.

The manufacturer is in a difficult position, receiving as he does a large number of suggestions and requests from operators for special construction. If he fails to comply with even ill-considered requests, he runs the risk of losing business at the moment, but, if he complies to get the business, he is in grave danger of putting out a product that will damage his reputation and also increase the cost of operating his plant. On the other hand, if the manufacturer fails to heed well-considered suggestions, he will be left behind in the march of progress. His is the responsibility of selecting the wheat from the chaff.

It is much to the advantage of all concerned to have the products kept reasonably to standard as by so doing costs should be reduced, weights reduced, stability increased and delivery augmented. Appearance of individuality of equipment may be obtained by special trim and finish on a standard product.

Experimentation to determine proper standards is most properly carried on in the laboratories and on the test vehicles of the manufacturer, but in these days of rapid change and sharp competition it is probably necessary at times to cut corners and try it out on the dog. Operators do not so much object to playing the dog if they are taken into the manufacturer's confidence and understand what is being experimented with. After all, road service in regular operation is the best test in most cases.

As previously mentioned, the demand for variation in chassis construction is not great. Engines and the units for transmitting the power are powerful and reliable. In general they are also quiet; those which are not are bound to lose favor.

Chassis frames are being built very rugged, and the tendency is to build them low so that steps are reasonable and center of gravity low. In the attempt to get a low floor-level the inclination has been to use small tires. The tendency has been to overdo this at the expense of reliability. Tires like small boys should be seen, not heard. Tires are only a means toward an end and, therefore, should have ample capacity to work at a reasonable pressure cushioning road shock so as to avoid damage to chassis and body and discomfort to the passenger and still operate for a reasonable mileage without failure.

Proper Springs and Brakes

One of the most important problems and one in which the general public is much interested is that of proper springs. I appreciate it is a difficult engineering problem to design springs that are satisfactory for both light and heavy loads and capable of absorbing both the light road-vibration and heavy shocks. Much opportunity for improvement in this respect exists. Possibly the use of some auxiliary device in connection with springs to get satisfactory riding-qualities is necessary. If so, the springs and auxiliary device should be designed to function together, and they should be standard equipment.

Brakes are another feature that should be diligently studied to improve effectiveness without undue strain on the vehicle, reliability, ease of operation and long life of wearing surfaces. As they increase in number motorcoaches are bound to get more and more attention from state highway inspectors, who will be very particular regarding effectiveness of brakes. This is as it should be. It seems to me that again in this respect the manufacturer should work out what seems to him to be the best type of brake for the particular vehicle he is producing and put it out as a standard and as adequate without auxiliaries.

From the financial point of view brakes are exceedingly important on account of their importance in avoiding accidents. Their maintenance is also important from the same angle so that ease of adjustment, accessibility for renewal and well-designed wearing surfaces of carefully selected material are of great interest to the operator.

Great progress has been made in providing chassis that can be depended upon for reliable service. The manufacturers have the right to expect that the motorcoach will receive more thorough attention than the private automobile and can build accordingly. But even in the motorcoach, ease of lubrication and accessibility for inspection, adjustment and repair will encourage proper attention and promote long life to the advantage of the owner and to the credit of the manufacturer.

Standardized Bodies

In body construction if the manufacturer can keep to a standard framing, he can make minor changes for individual purchasers without seriously interfering with his shop processes. If the operators will permit this, the manufacturers should be able to go far in the use of standard metal parts and jig-cut lumber. This should help in reducing weight, which is desirable, and at the same time aid in producing a body that will have long life free from vibration and noise.

Body dimensions are certain to be given much attention by the regulating authorities. I feel that the tendency will be to be more strict in limiting the length and width, as a strong hostility is developing against the large motorcoaches on the part of the private automobilist and his power in the legislatures is great.

The tendency has been to crowd as many seats as possible into a body without sufficient consideration for the comfort of the passengers. More consideration will probably be given to adequate spacing and seat width as well as to eliminating seats that are undesirable on account of wheel housing or other causes. The first tendency was to provide very narrow aisle space, but this was unpopular, and the general practice now is to be more generous. Passengers expect to be able to enter and leave a vehicle with reasonable freedom and to have a reasonable space to sit in. Recent body design reflects this attitude. Builders are to be complimented on the seats that have been developed for motorcoaches. They are comfortable, and as a result of experience are being constructed so as to be durable.

Finishing the Outside

In the selection of outside body sheathing it is desirable to have a material that is reasonably resistive to blows and scratches in the interest of economy in maintenance and continued good appearance of the unit. Painting is the one feature in which I would hesitate to even suggest any attempt at standardization. A casual observation of the multi-hued vehicles on the road indicates that any such attempt would be in vain. Nor is it necessary. I suspect, however, that we are going through somewhat the same experience as has the street car, starting out as some of them did painted in Highland plaids.

Much is to be learned yet regarding proper paints for durability. It is important for the manufacturer to be able to standardize on process of painting, as to change process is likely to affect his procedure in body work itself. However, based on their experience uptodate, it would probably be difficult to get operators to agree upon one process of painting. Standardization in this respect will have to wait upon further demonstration of the advantages of the newer methods.

INTERNATIONAL CRITICAL TABLES

THE National Research Council has arranged for the publication in five volumes of the International Critical Tables of Numerical Data of Physics, Chemistry and Technology, in the preparation of which the Council has had a large staff at work for several years. The Council has reserved to individuals who are members of scientific and engineering societies the right to purchase the volumes at manufacturing cost, $35, provided applications are filed with the National Research Council, B and 21st Streets, City of Washington, prior to the publication of the first volume, which is scheduled to appear early in 1926. The price after publication of the first volume will be $60 for the complete set, the total number of pages in which, it is estimated, will comprise 2500.

The material contained in International Critical Tables has been collected and critically evaluated by some 300 cooperating experts, including chemists, physicists and engineers of the United States, Canada, Great Britain, Belgium, France, Italy, Austria, Germany, Denmark, Switzerland, Holland, Australia, and Japan. The editorial expenses, about $170,000, have been contributed by American industrial firms and benevolent foundations. The work of the cooperating experts, which is practically gratuitous, may be assigned a money equivalent of not less than $300,000. The cost of printing and distribution will be about $100,000. The whole undertaking represents, it is stated, a money value of at least $570,000, of which the returns from subscriptions will represent only a minor part.

The scope of the material collected covers all available information of value concerning the physical properties and numerical characteristics of (*a*) pure substances, (*b*) mixtures of definite composition, (*c*) the important classes of industrial material, (*d*) many natural materials and products, and (*e*) selected data for selected bodies or systems, such as the earth and its main physical subdivisions and the solar and stellar systems. Publications of the world in all languages have been combed for data and much unpublished information has also been collected. In addition to their wide scope, the tables will contain many novel features of arrangement. Thus, for example, not only will it be possible to find readily all of the properties of a given substance or material, but it will also be possible in many cases to ascertain readily what substance or material of a given kind has the maximum, the minimum or a given value for any given property. This feature will be of great assistance in identifying a substance by its properties or in selecting a substance or material on the basis of a given property or combination of properties.

The principal language employed will be English. Much of the explanatory text, the tables of contents and the very complete index, however, will be given also in French, German and Italian.

RAILROAD FREIGHT TRAFFIC

FOR more than 2 years no net shortage of railroad cars has been reported, despite the fact that this period has been marked by the highest peaks in railroad history. The swiftness and reliability of transportation service maintained in recent years are in marked contrast to the long periods of congestion that were experienced during the war and again in 1920.

Freight traffic carried by Class-1 roads in August amounted to 41,723,156,000 net ton-miles, marking a gain of 14.4 per cent over the total for August last year and 3.4 per cent over that for the corresponding month in 1923. In the early part of the year, the freight movement was considerably smaller than in 1923, but for several months prior to August the margin had grown narrower. This year's figure is larger than that for any corresponding month in railroad history with the exception of August, 1920.—*Guaranty Survey.*

Operating Experience with Gasoline-Electric Motorcoaches

By R. HARLAN HORTON[1]

AUTOMOTIVE TRANSPORTATION MEETING PAPER

ABSTRACT

RESULTS obtained in 5-months' operation of a fleet of 130 gasoline-electric single-deck pneumatic-tire and double-deck dual-solid-tire motorcoaches by the Philadelphia Rural Transit Co. are described, and the author states that he knows of no other instance in which so large a fleet of motorcoaches has been placed in operation and given as dependable service with so little trouble. After this period of operation, the company finds more real enthusiasm and foresees more possibilities for the vehicles than at the outset and expects within a year to have operating data to show which will surpass any as yet presented.

Deliveries on the order for 200 of the new type coaches began in June, 1925, and by early November 130 had been placed in service. In this period the attention of the company has been concentrated upon the organization and equipment of garages, the training of about 250 men, the organization of a general shop-force, placing the vehicles in service, adjusting the service to the traffic and, in general, operating as an organization. No opportunity has been afforded to perfect the operation, to particularize and systematize carefully, to endeavor to realize maximum fuel-economy, and to determine the best maintenance program.

Outstanding advantages realized in the operation of this type of motorcoach are (*a*) rapid and smooth acceleration, which results in greater safety to passengers, reduction of claims for damages, faster running-time, reduction of labor costs, and a more attractive ride to sell to the public; (*b*) concentration of drivers' attention on the traffic, resulting in avoidance of collisions; (*c*) quiet operation, which reduces the number of complaints from residents along the routes; (*d*) decreased maintenance, which has made possible the cutting in half of the cost of regular maintenance, and (*e*) reduction of oil consumption.

The fundamental differences between the mechanical and the electrical equipment have affected greatly every phase of operation. The fact that the driver has no clutch and no gear-shift lever to operate affects vitally the two most costly classes of operating expense, namely, labor costs and accident claims, hence the operating company can well afford the cost of additional fuel that may be necessary to carry the extra weight of the electrical apparatus. During October, 1925, the average schedule-speed maintained on the urban routes was 11.91 m.p.h., the maximum miles per gallon of gasoline for the double-deck motorcoach was 4.2, with 60 per cent of these vehicles operating 3.3 miles per gal. or more, and the single-deck motorcoaches showed the maximum of 7.5 miles per gal., with 80 per cent operating over 4.0 miles per gal. By comparison, six mechanical-drive motorcoaches of the same make and size operating at Buffalo averaged in October, 3.98 miles per gal., or 0.70 miles per gal. better than the Philadelphia company's expected minimum. Whereas gasoline costs about 4.5 cents per mile, the wage cost per mile is about 14.5 cents per mile, hence a factor that affects fuel consumption 10 per cent affects operating costs about 0.45 cents, while a factor that affects speed affects the cost about 1.50 cents and also affects the fixed charges in the same ratio. Oil consumption in October averaged 1 qt. to 38 miles, as compared with 1 qt. per 24 miles by the six Buffalo mechanical-drive motorcoaches.

Reliability of the vehicle is of utmost importance, and the easier the maintenance is the more reliable the vehicle will be. At the start of operations the company adopted the customary program of inspecting the vehicles after every 2000 miles of operation but it is now studying the refinements that will be possible. A first step toward extending the period between inspections has been to establish inspections in one garage after each 4000 miles. The electric generators and motors need very little attention beyond oiling and greasing, and after 4000 miles plenty of lubricant remains in their bearings. The company is confident that the inspection intervals can be further increased, and intervals of 15,000 or even 25,000 miles do not appear to be an unreasonable expectation. It expects to change the entire principle of inspection and is working with manufacturers of electrical apparatus in the development of a watt-hour meter for attachment to the vehicles for measuring the power output or consumption, with a view to using the power consumption rather than mileage as a basis for determining when inspections are required. A brief description of the functioning of this instrument is given. Coordination of the reading of the instrument with office records of gasoline consumption of any individual vehicle will indicate positively when anything is wrong with the engine, the generator or the driver. In tests after overhauls, readings of the voltage and amperage will give an index of the functioning of the generator, and the watt-hour readings of a delicate meter installed for the purpose will show whether or not the motorcoach is in proper operating condition after an overhaul.

Major troubles that occurred in the early operation of the vehicles, such as overheating of the generators in excessively hot weather and with full passenger-loads from end to end of the routes, and means adopted to overcome them, are described. The usual amount of day-to-day minor troubles such as occur on any type of motorcoach has occurred and indicates only average performance, which, however, has been obtained without any special attempt at systematizing or perfecting the maintenance organization.

FIRST deliveries of the 200 motorcoaches that the Philadelphia Rural Transit Co. had ordered were made in June, 1925, and since that time about 130 have been placed in service. This has involved the instruction and training of about 250 men, the organization of a general shop-force and the organizing and equipping of two large garages. Hence, for the last 5 months we have been busily occupied in placing the vehicles in service, adjusting the service to the traffic, giving service to the public and operating as an organization without having had an opportunity to particularize and systematize to the degree of carefulness that we are now endeavoring to reach.

I know of no instance in which a fleet of coaches of this size has been placed in operation and given as dependable service with as little trouble as we have encountered. While the results have proved conclusively

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to us the great value of the electric drive, we have not as yet so completed or so perfected our entire operations that a complete set of statistics is available. I shall attempt, however, to give such facts as are reasonably indicative in character. We intend, a year from now, to have results to show which will far surpass any yet presented.

In the gasoline-electric motorcoach a generator, a controller and two electric motors have been substituted for the clutch, the transmission and the differential, thereby producing a vehicle that is unmatched for ease of control, for rapid and smooth acceleration and for quiet operation. That is the story of the electric drive in a nutshell. These results, however, together with the fundamental differences between mechanical and electrical equipment, have affected every phase of operation to a great extent.

Smooth, Rapid Acceleration Reduces Costs

From the viewpoint of the operating company, the fact that the driver of a vehicle has no clutch to pedal and no gears to shift but obtains his acceleration merely by depressing a pedal is of utmost importance because it affects vitally the two most costly elements of operating expense, namely, labor costs and accident claims. The operator can, therefore, well afford to purchase the additional fuel that may be necessary to carry the extra weight of the electrical apparatus. A gain in rapidity of acceleration means a gain in average speed, and a gain in speed means not only a reduction in the cost of wages per mile, due to getting more miles per hour of drivers' time, but also a more attractive ride for the customer, as the demand today is "Get me there quickly and comfortably, but above all, quickly."

I do not want to intimate that a mechanically driven vehicle cannot accelerate as rapidly as the gasoline-electric motorcoach but do contend that such acceleration is not feasible in day-to-day operation. We have some drivers who could, and would, shift gears rapidly enough to maintain this rate of acceleration. However, not all of our drivers, nor a majority, nor even half of them, could, or would, do so. In fact, drivers of that class are greatly in the minority. Even were it possible to provide the men necessary to produce these results, it is my opinion that accidents would increase to such an alarming extent that the pace could not be maintained.

In the month of October our over-all speed was 10.87 m. p. h. This figure is obtained by dividing the total time the motorcoaches were on the street into the total mileage they made. The average schedule-speed, which is the result of dividing the miles traveled by the actual running-time between terminals, is 11.91 m. p. h. In these calculations the interurban motorcoaches have been eliminated. I do not have figures from all operating companies but shall be much surprised to learn of any company that maintains an average speed as high as this in urban service.

Offers More Attractive Ride To Sell

The smoother the acceleration is the more attractive ride we have to sell, since our present patrons are, in general, lovers of luxury and ease and the next most attractive thing to speed is comfort. The motorcoach that will start smoothly, eliminating as much jostling of passengers as possible, supplies a more attractive ride and goes farther toward inducing them to leave their own automobiles at home than many other factors that are given more thorough study. Consider, also, from the engineering viewpoint, what it means to eliminate the three sharp surges that occur in every starting of the mechanical-drive motorcoach as the clutch is let-in after shifting gears. The vehicle with the electric drive starts and accelerates to its maximum speed with a gradually increasing torque and without at any time putting a severe stress upon any part of the mechanism. We cannot today indicate how much this will affect the life of the mechanism. That it must mean an improvement is self-evident. The maximum mileage that we have accumulated with any one vehicle is with motorcoach No. 207, that has been operated a total of 15,750 miles, beginning in May, 1925. During this period it has been pulled-in four times: in June, because of a clogged gasoline line; in September, to have the brakes adjusted; again in September, for being out-of-time, and in the latter part of October, for a broken wire that interrupted the lighting circuit. This may not appear to be a positive indication of what the usual results will be, but it is the best we can offer to date.

Accident Claims Greatly Reduced

Engineers may not be aware of the difficulties that transportation companies encounter from accident claims. I believe that the safety-first movement which is now so general was started by the transportation companies and that originally, if not now, the urge toward it was occasioned more by fear for the pocketbook than for the safety of the public. This is not stated as criticism or condemnation but merely to point out that safety is a plain common-sense business proposition. Transportation companies long have been the target of the sharper, the impostor and the opportunist, who will seize upon any pretext to obtain money in settlement of a claim, whether any loss was involved or not. Particularly has this been the case with regard to that class of accidents known as "falling in or from the car." These might be reclassified into three divisions: (*a*) actual serious injuries that may be caused by a sudden start or stop that throws a person to the floor and results in an injury, which are most regrettable and most expensive; (*b*) false injuries, claimed by the trickster who boards a vehicle and, while the vehicle is starting, deliberately falls and claims an injury to the back—physicians say that it is almost impossible to determine whether the claimant is malingering or not, and (*c*) accidental falls without injury by passengers who afterward realize or are told that it might be advisable to go to bed for a few days and mulct a little spending money from the transportation company.

With an easy and smooth acceleration, many of the accidents in the first and third classes can be eliminated, and even in the second class the effect can be minimized, because it is difficult to convince a jury of a sudden jerky start when its members are accustomed to riding in the motorcoaches and realize the contrary and are also informed that it is impossible for the driver to start the vehicle in such a manner.

One more safety factor that we consider of major importance is that the elimination of gear-shifting has made it possible for the driver, when starting up and leaving a corner, to give his whole attention to the traffic on the streets. This operation involves the greatest hazard of collisions and any way in which the drivers' duties can be lessened helps toward the prevention of accidents.

Quietness Stills Residents' Complaints

Another interesting sidelight on gasoline-electric motorcoach operation relates to the phase of quietness.

Because of franchise obligations, we were obliged to rent a few single-deck mechanically driven gear-shift motorcoaches and place them in operation on a route in Germantown. Part of this route was through a high-class residential section and it so happened that a comparatively steep grade was encountered in this particular neighborhood. Operation had no sooner begun than complaints began to come in, particularly from the resident who lived right at the place where the driver had to shift from high into second speed. All of these residents complained of the noise and the grinding of gears, contending that their rest, peace and quiet were disturbed. They were informed that the equipment was to be used only temporarily and that upon delivery of the new gasoline-electric motorcoaches the noise would cease. They were extremely skeptical and it was with great difficulty that they were restrained from taking the matter before the authorities in an attempt to have the route changed. In the meantime, the single-deck gasoline-electric motorcoaches arrived and since they have been placed in operation not a single complaint has been received from this locality and, so far as noise goes, the residents are scarcely aware of their operation.

Regular Maintenance Cut in Half

Reliability of the vehicle is another matter of utmost importance to the operator, and the easier the maintenance problem is the more reliable the vehicle will be. Most operators have established a program of inspection after every 2000 miles. We adopted the same principle when starting our operation and are now just beginning to study the refinements that will be possible. The first step has been to increase the interval between inspections in one garage from 2000 to 4000 miles, and we have no doubt of its success. Therefore, so far as labor cost is concerned, the regular maintenance expense has been cut in half. What we shall be able to do with the major annual overhauls remains to be determined. This first step has been predicated on studies that have demonstrated that, although the engine oil should be changed more frequently than every 4000 miles, it is not likely that the engine will need attention oftener. The inspection of generators and motors has shown that we have very little to inspect and that at the end of 4000 miles plenty of lubricant for the generator and motor bearings was still available.

This first change in the inspection period has just been made and therefore I cannot give data as to its results. We are confident, however, that it is only the first step. What the limit will be we are not able to say; inspections at intervals of from 15,000 to 20,000 or even 25,000 miles do not appear to us to be an unreasonable expectation. However, we expect to change the entire principle of inspection. We have been working with the manufacturers of electrical apparatus to develop a watt-hour meter for measuring the power output or consumption. Heretofore, mileage has been used as a measure of work done, but we submit that miles are extremely variable and that 2000 miles of operation on one route may represent far more work done than 2000 miles of operation on another route. With the placing of these meters on the motorcoaches, we shall have a positive index of work done. A generator output of 1 kilowatt-hour represents a definite amount of work, regardless of the conditions under which it may be called upon to do that work. The same principle applies to the gasoline engine. Just so much work is required to produce 1 kilowatt-hour, and it makes no difference whether the vehicle is operating up-hill or down-hill, under load or light. The amount of work done by the apparatus is the same for each kilowatt-hour produced or consumed, although the number of kilowatt-hours produced and consumed per vehicle-mile may vary greatly.

The whole theory of inspection is to determine a point at which the apparatus has done such an amount of work that it requires attention and inspection to prevent damage and failure of important parts if it is operated further. With the watt-hour meter we shall be able to determine just how many kilowatt-hours can be produced and consumed before this attention is necessary. The meter has three dials, each equipped with a moving and a stationary hand. The stationary hand is set at a point representing the amount of power that may be produced or consumed before inspection is necessary. When the moving indicator coincides with the stationary hand, indication is given that inspection is due, after which the moving hand is reset at zero and another cycle of operation is started. This eliminates all of the bookkeeping by the shop forces that formerly was necessary to keep account of mileage and to direct that the motorcoach be brought into the shop at the end of 2000 or 4000 miles. The shop foreman or his clerk, by glancing at the meters each night, can determine which vehicles are due for inspection and overhaul the following day.

Kilowatt-Hour Related to Fuel Consumption

Moreover, the accounting department will keep a record of the gasoline consumed by each vehicle, the mileage covered and the kilowatt-hour produced and consumed. The kilowatt-hour per gallon of gasoline consumed should be fairly constant and definite after once having been determined. The instant that a particular motorcoach shows a reduced number of kilowatt-hours per gallon, definite and positive indication is given that something is wrong with the engine, the generator or the driver. The number of kilowatt-hours per mile is not so accurate a measure, for on the mileage basis the variables, such as load carried and the characteristics of the route, must be taken into consideration, but it nevertheless gives as good an index of the efficiency of the electric motors as the mechanical-drive motorcoach has for its entire operation.

After the inspection and the overhaul are completed, the motorcoach will be connected with a water rheostat and operated under test with a given quantity of gasoline, probably 1 gallon. In this test the engine will be accelerated gradually from idling speed and the voltage and amperage read at various speeds. This will give an index as to whether or not the generator is functioning properly and producing the correct amount of current at the various speeds. A more delicate watt-hour meter will be installed for this test and the total number of watt-hours for this gallon of gasoline will be determined. Thus, at the close of the test, which should not consume more than 15 min., we shall be able to tell whether the inspection and overhaul have put the motorcoach in proper operating condition.

With the mechanically driven motorcoach this most important question of functioning is determined by the mechanic, who, merely by listening to the engine, decides whether it sounds all right, seems to respond quickly enough when the gasoline is fed to it and whether it seems to accelerate properly on a test run. Results of the inspection are judged entirely by the impression made upon the tester, and, although these men become most expert, I submit that the vehicle may be turned out in a faulty condition that would escape notice

in such a test. We have available, in the method just described, a positive, definite and scientific test for the two most important parts of the vehicle and we are now working and experimenting upon apparatus that can be placed under the rear wheels to determine precisely the energy delivered at the road. This will give a further test as to the performance of the motors.

Gasoline Consumption Has Been Satisfactory

Despite numerous handicaps that were incidental to the initial operations, our gasoline consumption has been satisfactory. October's record showed the maximum of 4.2 miles per gal. for the double-deck motorcoaches, with 60 per cent of them operating 3.3 miles per gal. and over. The single-deck motorcoaches showed the maximum of 7.5 miles per gal., with 80 per cent operating over 4.0 miles per gal. We are loath to prophesy what the consumption may be later, but we have not as yet made any attempt to educate the drivers to save gasoline. We are sure, however, that if 60 per cent of the double-deck vehicles are operating 3.3 miles per gal. or more without any such effort, this can be established as the minimum and that the average should run substantially higher.

A recent accomplishment made by four of our single-deck motorcoaches may be of interest. The International Railway Co. of Buffalo, which is also under Mitten Management, was sorely in need of four motorcoaches immediately and on Oct. 25 these vehicles left Philadelphia for Buffalo and made the run of 413 miles in 17 hr. actual running-time, consuming 80 gal. of gasoline or traveling 5.16 miles per gal. No trouble whatever developed and, when the fact is taken into consideration that the whole trip was made in a driving rain, it makes the accomplishment all the more remarkable.

The company has in operation in Buffalo six 6-cylinder ZY-type Yellow Coaches that are almost duplicates of the ones operating in Philadelphia except that they are equipped with mechanical drive. For the month of October their gasoline consumption averaged 3.98 miles per gal., which is approximately 0.70 miles per gal. better than our expected minimum. This may be the price that we shall have to pay for the advantages of the electric drive, although I am not ready to concede that, after we have made an effort with our drivers such as the Buffalo company has made, our gasoline consumption may not very nearly equal theirs.

In the long run, what must be determined is that the price we pay will produce equivalent results. Fundamentally, when talking of gasoline consumption, we are talking of costs that are about 4.5 cents per mile, and when we speak of the advantages of the electric drive we mention first and as most important the high average-speed, in which case we are dealing with costs of about 14.5 cents per mile for wages alone. Therefore, a factor that affects gasoline consumption to the extent of 10 per cent will affect costs to the extent of about 0.45 cents, but a factor that affects speed to the extent of 10 per cent affects costs to the extent of about 1.50 cents for wages alone, and that furthermore affects the fixed charges in the same ratio, because as speed increases it is possible to give the same service with less equipment.

The foregoing discussion has concerned the fuel consumption of double-deck motorcoaches. I have no figures for six-cylinder single-deck vehicles with which to compare our records.

Oil consumption is always a matter of concern to the operator, and in this respect our records have been not only most satisfactory but surprising. We find the six-cylinder mechanical-drive motorcoaches in Buffalo averaging in a month about 24 miles per qt. of oil, while the gasoline-electric motorcoaches in Philadelphia show an average of about 38 miles per qt. This result is obtained because of the lower peak of revolutions per minute with the electric drive and the lesser number of engine revolutions per minute in this type of vehicle.

Troubles That Have Been Overcome

No automotive vehicle has been constructed that does not give trouble at times. We have had some of these troubles but none have developed as yet that have shown us that the gasoline-electric principle is not correct or that it has not proved to be satisfactory and reliable. In fact, daily operation proves the contrary.

The first difficulty that developed was with a grounding through the brush holders of the generator. It was found that what they needed was a little non-metallic insulating paint, which, upon being applied, eliminated the trouble. We have since found that it will be advisable to provide a means whereby the tension on the brushes can be adjusted, and provision for this adjustment is being made, but, even though it has not yet been accomplished, we had but one case of brush-holder trouble in October.

A little trouble was experienced at the outset with the loosening of the bands on the armature. These bands would be thrown off by centrifugal force, jam up inside of the motor-shell and around the commutator and produce a fine display of fireworks that gave the bystander an impression that the motor was afire. The truth is that one band on the armature was wound so that it came over the edge of the commutator and would come loose. These bands have been removed from most of the motors and narrower bands put in their place. These narrower bands have given no trouble.

Unusual Conditions Met At Outset

Difficulty was experienced at the outset with the heating of the generator. The first 25 coaches were put into service under the most trying circumstances. It was necessary to act quickly and the drivers were not thoroughly experienced. The street temperature was running between 90 and 100 deg. day and night. This warm weather, together with the fact that the vehicles had just been started in operation, induced everyone who could find a dime to ride, with the result that the new equipment and new drivers were carrying capacity loads from one end of the line to the other end with record-breaking street temperatures. Is it any wonder that occasionally the water in a radiator would boil or that a generator would heat-up? With all the boiling of the radiator and heating of the generator, we did not have a single electrical failure. Throughout the entire operation thus far, we have not lost an engine bearing. Temperature tests showed the generator heat to be abnormal, and we found a very simple cure. The fan on the engine and the fan on the radiator were both working together in a vain attempt to cool the generator with all of the hot air cast-off by the engine, therefore we cut additional louvers in the side and top of the hood and found it possible to direct enough cool air to the generator to correct the condition.

We also have had some difficulty in retaining the grease in the rear axle. It has taken a little longer, perhaps, to cure this trouble than the others. It seems that, with the worm traveling at such high speeds, the oil in the carrier

is thrown out with considerable force. Also, particularly in warm weather, considerable heat has been generated by the brakes and resulted in reducing the viscosity of the grease in the wheel bearing. To determine which lubricant was getting away and at times getting on the brakes necessitated considerable research. This study has resulted in the development of special seals for the carrier and near the wheel bearing, and we anticipate that our troubles from this source will be over soon.

Usual Number of Minor Troubles

The usual number of day-to-day troubles has occurred and the month of October shows an ordinary number from gasoline tanks, gasoline lines, engines, springs, wheels, storage-batteries, ignition, registers, bells, signs, fans, steering-gears and head-lamps. In this respect we have nothing to brag about and nothing of which to be ashamed. The record represents merely an average performance, but this average performance has been obtained without any special attempt having been made to systematize or perfect the maintenance organization. We have been too busy trying to keep the vehicles moving, conditioning new motorcoaches and starting new lines to get down to the fine points as we hope to do this winter.

Moreover, on our principal routes we have been handicapped greatly by a severe street condition that was brought about largely by the heavy trucks that are operating in subway construction work and the lack of attention and repairs to the streets because of the City's policy that maintenance of the streets may well be deferred until this construction has been completed.

Such is the story of the gasoline-electric motorcoach from the operator's standpoint. Some gaps are to be filled in with information that can be supplied later, but, after the first 5 months' of operation, we find more real enthusiasm and foresee more possibilities for the vehicles than at the outset. In this period the gasoline-electric motorcoach has been ordered or placed in service in Atlanta, Kansas City, Los Angeles, and Portland, Ore., and the announcement was made recently by an officer of the Albany, N. Y., lines, which have been operating this type of motorcoach for about the same period as the Philadelphia Rural Transit Co., that their experience had been so satisfactory that they intend to standardize on this class of equipment.

WORLD TRADE

THE world's trade record for the fiscal year ended June 30, 1925, contains some unusually interesting features. France, for instance, gained about 6⅔ per cent, a small fraction over the general average. Her's was a substantial growth, however, and represents an increase over 1913 of about $744,000,000, at 1913 prices, or a little more than 25 per cent. That is almost as much gain as this Country has made. Moreover, France has turned an import balance into an export balance, which is of vital importance to her under present circumstances. She had an excess of exports for this fiscal year of $162,000,000. In 1913 her merchandise imports exceeded her exports by nearly $300,000,000. No other European country makes such a showing.

Germany and Italy made the highest percentage-increase in their foreign trade this year, Germany with 28 per cent and Italy with 29 per cent. But in both cases the increase was due very largely to expanded imports, with effect, consequently, quite different from that in the case of France. The situation of Germany, in fact, is worthy of careful consideration. Her total trade grew up to almost pre-war proportions, if value alone is considered, but is still far below that of 1913 when stated in terms of 1913 prices. This total was $4,835,000,000, which at pre-war prices would be about $3,223,000,000. But in this were imports valued at more than $3,000,000,000. Her excess of imports for the year was $1,312,500,000, against an excess of imports for 1913, when she was a creditor nation, of only $160,000,000. Her export trade, on the other hand, which was $2,403,000,000 in 1913, was only $1,761,250,000 this year, or about $1,174,000,000 at 1913 prices. That is, her export trade for this year was still less than half the volume of the last year before she went to war.

Germany's colossal excess of imports for this year is explainable partly, perhaps chiefly, on the basis of foreign loans and credits; partly on the basis of income from German assets held in other countries; and partly on the basis of repatriated German capital, that had fled the country during the debauch of the mark. Just what influence this great excess of imports has in enabling Germany to make payments on her huge war debts is a question.

An important New York City bank recently published a statement of German conditions which estimated her industrial output at 66 per cent of pre-war figures, her working capital at 75 per cent, her bank capital at 30 per cent, and the gold value of her bank deposits at 25 per cent. She must import about one-sixth of her food and half of her raw materials. Living costs are high and increasing. Capital is scarce and interest rates are high. Between 500,000 and 600,000 men are out of work. Wages are reported at from $1.25 to $1.50 per 8-hr. shift. Taken all together it is a rather dreary picture. But all reports agree that a ready disposition to work, which is at least one hopeful feature, exists.

The Italian increase of trade is also due to huge imports, a gain on that side of more than $264,000,000 having been made. Italy has had an adverse balance right along, but this year she increased it by nearly $130,000,000. No loans to Italy have been floated in the United States this year, but an agreement was made by certain American banks, in June, to extend credit to her aggregating $50,000,000, for use in stabilizing exchange. It is reported that this credit has not yet been called upon; but even if it had been used immediately it could hardly have had any effect upon the trade figures for this fiscal year. Italy benefits, of course, by very large tourist expenditures, and also by extensive remittances from her emigrants to this Country. These sums, however, could hardly account for so large an excess of imports.

Great Britain is still the only country in the world whose foreign trade exceeds that of the United States. Her total for the 12 months ended with June was approximately $11,100,000,000 against our total for the same period of $8,799,225,000. But the great part of British trade was imports, which aggregated $6,546,000,000, as against American imports of $3,871,000,000. In the export trade we exceeded Great Britain, our figures being $4,927,000,000 against hers of $4,548,000,000. She made marked gains, however, in her re-export trade, where last year she lost. This year her re-exports amounted to more than $700,000,000, nearly nine times as much as American re-exports. Her gain for the year was greater than our whole re-export trade.

The long continued unrest in China has been accentuated during the year, with consequent detrimental effect upon trade. Despite that, however, the growth of our trade with the Orient is still greater than that of our Latin-American trade.—From an address by President Farrell, of United States Steel Corporation, before the National Foreign Trade Council.

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Problems of Motor-Vehicle Administration by States

By Robbins B. Stoeckel[1]

Automotive Transportation Meeting Paper *Illustrated with* Photographs

ABSTRACT

STANDARDIZATION of law and of equipment as it applies to the motor vehicle is discussed first, to the effect that traffic conditions call for standardization, that existing conditions make for different degrees in the whole problem, and that standardization must follow and be adapted to conditions since it cannot be attained in advance. With regard to standardization of manufacture and of equipment, the conclusions are that it is a part of uniformity of law and can take place only as an expression of the law or of a universal practice.

The loading and the overloading of passenger cars and of commercial motor-vehicles, including special considerations of loading from the standpoint of the capacity of the vehicle, are dwelt upon at length, motor-vehicle taxation is accorded similar treatment, and this portion of the paper is summarized by statements that loading is considered from the two viewpoints of total road-load and of loading to registered capacity, in relation to wear-and-tear on highways and to safety; that the "leeway" principle is a dangerous one; and that interstate traffic creates hardship under existing laws.

In commenting upon the motorcoach, a distinction is made between intrastate and interstate traffic and the considerations for each are detailed, the conclusions reached being that the intrastate vehicle is under adequate control by existing laws, but that any determination of desirability for its purposes should include a consideration of the traffic in which it will run and, further, that the interstate vehicle is not controlled, new state laws being needed to authorize motorcoaches, to route them and to manage them.

In most jurisdictions the measurement of what a proper speed is on the highway is determined by the test as to what is reasonable at a given place under the conditions that exist there. The principle is summarized in a statutory direction that one may proceed at a reasonable rate of speed. This subject is discussed in its several aspects, inclusive of "average rate" of speed and rates of speed that are slow enough to be dangerous, it being stated in conclusion that the best speed-law is that which prescribes a reasonable rate of speed, that vehicles must be capable of maintaining the average rate of reasonable speed on the highway and that the tendency of the situation is to evolve faster-traffic motor-vehicles of a large type.

As to restrictions regarding the size of vehicle, it is stated that, as necessity increases and the so-called "road rent" of a vehicle becomes higher, it will be natural that legislatures will restrict the size of large vehicles even more, the tendency probably being to throw the carrying of freight into smaller, faster moving vehicles as determined by the conditions of traffic itself. All the subject heads of the paper which deals with the pressing problems of administration and enforcement and that are now before the states are, properly, subjects for standardization. The problems are becoming more, rather than less pressing. The state viewpoint, taking into consideration the welfare of all the people who use the highways, will demand more and more management and restriction. Engineers and manufacturers will be influenced to produce a type of vehicle which is capable of average performance when considered in comparison with all the other motor vehicles.

THE purpose for which the motor vehicle exists is to move persons and things expeditiously and safely from place to place. As a traffic machine, it has no fixed distance or mileage limit; so, its use is not bounded by any territorial limit. The immense increase in numbers and the consequent multiplication of problems of movement and safety, coupled with the fact that standardization seems admittedly to be a subject for state regulation, make it imperative that the laws and methods of one jurisdiction be compared with and adjusted to those of another. Not only do fairness and justice to owners and operators demand it but, even more than that, the condition as a whole and its practical management call for standardization to as great a degree as is practicable. This principle will be discussed from two standpoints, on present conditions, the standardization of law and the standardization of equipment.

Standardization of Law

A motor-vehicle law, to be practicable and effective, must meet the conditions that exist where it is to be administered. It must also be drafted so as to be a suitable instrument for the regulation of all highway users, and must provide proper punishment for the criminal. Standardization of law must be founded upon these principles. It is decidedly apparent that the highway-traffic problem of the separate states is vastly different in degree. That distribution of cars is comparable to distribution of people is self-evident. The more people, the more cars there are. Table 1 shows the increase in the number of motor vehicles in the United States in 5 years.

Another factor entering the problem is the square mileage, for it is obvious that a congested population with a large ownership of cars operating in a small territory will create a vastly greater number of traffic complications and hazards and, consequently, require more law and enforcement, than will a spread-out popu-

TABLE 1—MOTOR-VEHICLE REGISTRATIONS INCREASE IN THE UNITED STATES

Year	Registration	Gain, Per Cent
1920	9,231,941	22
1921	10,463,295	13
1922	12,238,375	17
1923	15,092,177	23
1924	17,591,981	17

[1] Commissioner of Motor Vehicles, State of Connecticut, Hartford, Conn.

TABLE 2—AREA, POPULATION AND MOTOR-VEHICLE REGISTRATION OF THE UNITED STATES COMPARED BY GROUPS, FOR 1924

Section	Number of States	Area, Sq. Miles	Population	Registration
Eastern	13	226,411	36,532,303	4,880,044
Middle	14	831,252	40,449,787	7,465,258
Southern	13	1,016,615	27,224,351	2,954,529
Far Western	9	952,550	9,295,485	2,299,694

lation of approximately the same number of people and cars operating in a larger territory and over a greater mileage. For example, the population of Connecticut and that of Nebraska are about the same; but Connecticut has 5004 sq. miles and, in 1924, had a registration of 224,771 cars, while Nebraska has 77,520 sq. miles and a 1924 car-registration of 380,715. Connecticut traffic, therefore, will be so congested when compared with the Nebraska traffic that an entirely different distribution of problems will exist. In passing, let it be said that the conclusion should not be drawn that there is no similar traffic in these two compared States. Table 2 shows the area, population and motor-vehicle registration of the United States compared by groups, for 1924.

Problems created by city traffic unquestionably will be about the same all over the United States, except as to frequency and recurrence. In San Francisco, the problems of direction and enforcement will not differ greatly from those of New York City. If the point has now been made, it is clear that standardization of law as to traffic cannot well be based upon any one element; that is, it cannot be built upon population, territorial extent, number of cars or any single characteristic, but must be founded upon the whole existing condition of traffic. Standardization of laws and regulations for similar traffic is possible, but the law must be built-up to meet the demands of the traffic as to the degree that the problem has reached.

Uniform Law and Model Law Differences

A uniform law can be defined as one that governs a condition in different jurisdictions by identical principles, language and penalties. A model law is a form to work to, which within its scope, might have all possible principles expressed in tested language and have minimum and maximum penalties attached. From such, a selection to fit any condition can be made.

Management of traffic is like the exercise of a craft by a craftsman, let us say by a cabinet maker. If he needs a rough bench, he can build it with a hammer and a chisel; but, if a delicate inlaid chair is wanted, he uses many fine tools in addition to the crude ones. Traffic is like that. Where it is simple, few and simple enforcement machines are required. Where it is complicated, those persons charged with its management need every possible tool. So it constitutes an argument against a standardization of laws in the sense that they are to be uniform as distinguished from model, that to make a uniform law and present it to any jurisdiction will be to turn over expensive and unneeded machinery. Standardization must take this into account. To try to impose uniformity faster than like or identical problems develop will not work out. A uniform law is a complete set of tools. Should such tools be delivered to a workman, discretion and the ability to determine which tool is to be used, how, when and for what purpose must be left to him.

A Conference of Motor-Vehicle Administrators already is actively at work on standardization in the East, and a Middle Western Conference that is not so active but is doing something. The Southern Conference is, apparently, doing nothing, and no attempt has as yet been made to organize any conference in the far West. It has been found in the activities of the Administrators of the East, forming a conference of 12 states of which the representatives meet four times a year, that certain practices and principles can be standardized, such as the process of registration, features of road driving by certain road rules, the examination of intending operators and the general management of everything relating to the administration of laws that are at all alike on similar problems that have become identical, so the principles stated are actually being carried out with good effect. Thus,

(1) Traffic conditions call for standardization
(2) Existing conditions make for different degrees in the whole problem
(3) Standardization cannot be attained ahead of conditions; it must follow and be adapted to conditions

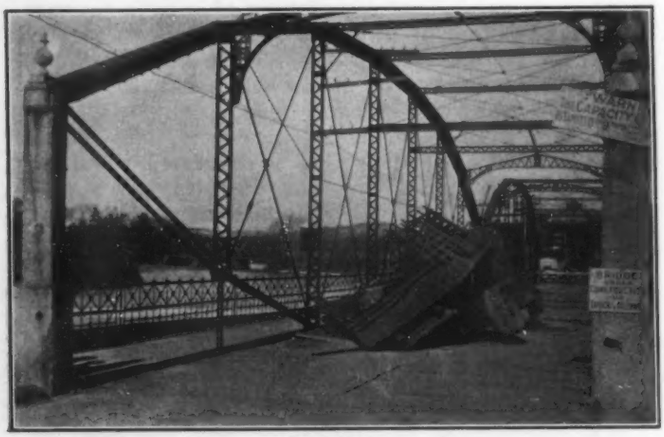

Fig. 1—Disastrous Result of Overloading
An Overload of 6 Tons and Heedless Disregard of the Plainly Visible Warning Signs Were the Two Causes of the Disaster Illustrated

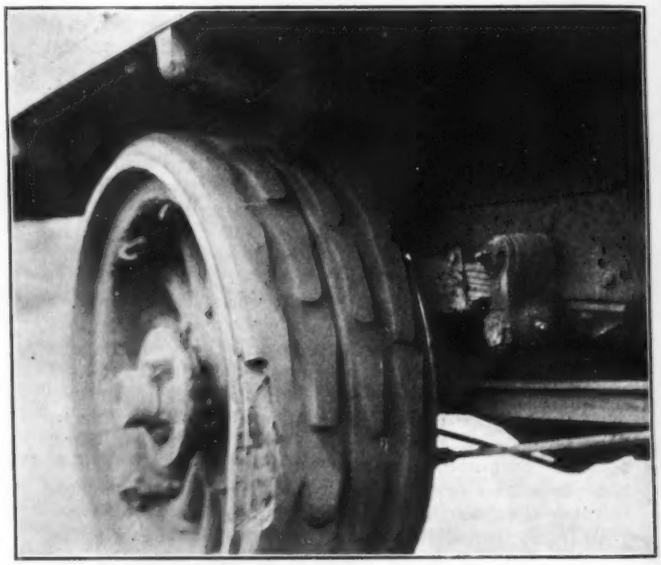

Fig. 2—Causes of Damage to Highways
The Heavy Overload on the Truck Shown Causes the Vehicle To Inflict Damage to the Highway, Due to Its Defective Tires. The Damage Is Many Times Greater Than If the Loading Were Normal

Manufacture and Equipment Standardization

Along similar lines of argument it can be predicated that standardization covering manufacture and equipment of a motor vehicle is a part of uniformity of law. Standardization of manufacture and equipment is the manufacturer's expression of the law. Competition in the manufacture of cars has produced high-grade equipment from the standpoint of artistry and mechanical perfection, and the emergencies that the operator has to meet in the ordinary running thereof have, in manufacture, evolved and developed effective safety mechanisms.

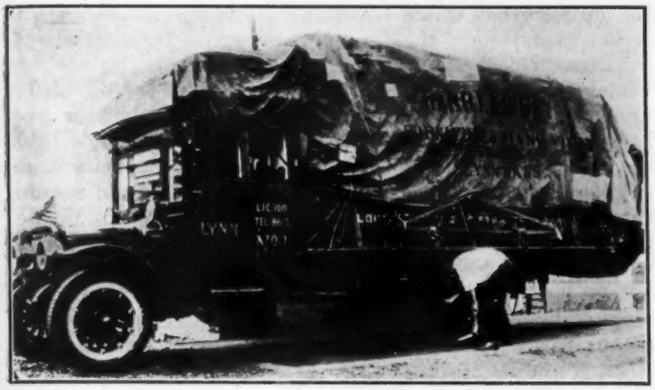

Fig. 3—Inspection of Vehicles for Overloading
The Method Employed in Weighing A Vehicle That Has the Appearance of Being Overloaded Is Indicated. A Portable Scale Is Inserted between the Wheel and the Roadbed

Where the laws in the different state-jurisdictions are alike or similar, the manufacturer can build to them. No standardization should, however, be so exact as to make parts and accessories identical but, rather, the principles that they express should be made uniform. Thus, invention and competition will not be hampered. From the standpoint of a state, this is a subject of selection and agreement. For example, if the states could all agree that a number-plate holder must by law be placed on a car at a certain point in the front and in the rear, then the enforcement of that agreement would necessarily standardize the number-plate holder to the extent that it would need to be of sufficiently good type to carry the number plate safely in that location. So,

(1) Standardization of manufacture or equipment is a part of uniformity of law
(2) It can take place only as an expression of the law or of a universal practice

Loading and Overloading

Types of car are distinguished legally for purposes of registration and service by the design of body of each type. A passenger car is *designed* for passengers, a commercial vehicle for freight, a combination vehicle for both passengers and freight or for either, and a public-service vehicle for both or for either as best suited to the public need. No single principle relating to the management of motor vehicles by states has been less understood than that of the load and the overload. The conditions naturally have been the most aggravated in the cases of large commercial-vehicles, but it may be useful to cover the other types briefly as well.

For safety and comfort to enforce a principle that the passengers can all be seated or, at least, be so well placed in the car as not to be tossed about and injured is enough. A passenger car should carry only as many people as seats are provided and it is good practice to have a law that its seating capacity is its limit of safety. But it is seldom that such a car is overloaded and, when it is, the ample margin of safety that designers and builders have allowed is able to care for the strain. So, in a consideration of loading and overloading, enforcement on this type of car is negligible; but the car is made by the manufacturer for the number of passengers who can sit, which means that all its brake equipment and machinery is built for that number and, when any serious overloading occurs, it ought to be a violation of a motor-vehicle law, because, by such overload, the brakes and the safety equipment of a car may be made ineffectual.

Fig. 4—Permanent Truck-Scale Installation
For Determining the Weight of Loaded Trucks, Thus Ascertaining the Amount of Overload, the Type of Truck Scale Shown Is Being Used Successfully in Connecticut

Commercial Motor Vehicles

Most states have now arrived at the point where a definite total road-load is a part of their law. This is one of the important principles that could be made uniform under the standardization plan set forth in the first part of this paper. The reasonable total road-load for present construction is apparently around 26,000 lb. It is essential that a uniform definite and total road-load be determined so that the highway administration of each state can look into the future and build its roads to that amount. Sometimes the point is made that a highway ought to be built to carry anything. This sounds liberal and like good sense, but certain features in connection with carrying loads on the highway ought also to be considered in any argument with the persons who make that claim.

Table 3 shows the classification of motor trucks registered in Connecticut in 1924.

About nine-tenths of the total traffic on the highway is under 10,000 lb. A good gravel road or a good macadam or a bituminous road will carry such a weight

Fig. 5—Overloaded Truck Mired in a Highway
Conditions on Highways in Connecticut Are at Their Worst in the Spring Season When Frost and Moisture Are Working Out of the Ground and the Earth Is Settling. The Illustration Shows an Overloaded Truck Stalled on Such a Highway

TABLE 3—MOTOR TRUCKS REGISTERED IN CONNECTICUT IN 1924

Capacity, Lb.	Number Registered
5000 and Less	30,380
5001 to 9999	1,944
10,000 and More	1,455

almost indefinitely. Such construction costs comparatively little to build and to maintain so that, when the argument that a road ought to carry anything is made, it is for the benefit of less than one-tenth of the entire traffic that will pass over it. Therefore, it is apparent that if at any future time a road-building policy which will make a road that is suitable for the heaviest loaded vehicles is adopted, these large and heavy motor-vehicles that demand such a road ought to pay for the extra cost.

It has been suggested by Commissioner Macdonald of Connecticut, as a plan which could be carried out, that all the highways of the different states be graded, it being understood that a Grade-A highway will carry anything, that a Grade-B highway will carry all the traffic up to and not exceeding 10,000 lb. and that a Grade-C highway will be practically a country road for light traffic only. Then his plan is to segregate vehicles so far as possible by the issuance of permits and by routing of the heavy vehicles. Whether this actually can be done remains to be seen. It sounds as though it might be a development of the rather far-distant future. Present policy seems to indicate standardization of the total road-load.

When the builder of a vehicle puts it on the market he usually guarantees it to carry a definite determined load. This guarantee ought to fix its load rating. It is clearly against public policy to allow any user of a vehicle to trespass upon the "margin of safety" over such rated load, and the conclusion is that no vehicle ought to be loaded to carry more than its guaranteed or rated capacity. Bad effects due to overloading, to recklessness and to neglect are illustrated in Figs. 1 and 2.

In many states, the law that governs loading of motor vehicles has been adapted to this rule and, in practical experience, the builder's guarantee or rating has been adopted as the most satisfactory basis for the determination of proper weight; but a discrepancy soon develops between the builder's guaranteed rating and his sales argument. In the past, the state administrator in charge of enforcement of this rule has repeatedly found himself confronted by a situation in which the builder had, naturally, in the course of his business, attempted to get his rating down as low as possible for the purpose of securing registration of his vehicle at the lowest cost. This sales argument was developed to a point where a salesman could explain the low rating and maintain that, although a commercial vehicle is rated at a fixed load, it may safely be used to carry a considerably larger one. If the state administrator had not been competent, this would have meant that many makes of commercial motor-vehicle could be registered at low ratings and carry loads over such ratings.

As a result of the practice outlined, it has been a common occurrence for an administrator to find on his highways commercial motor-vehicles loaded to far more than their rated capacity; those vehicles usually being in the hands of innocent purchasers who were unaware that they might be disobeying a law which expressed a public policy. Within a year, it has been an entirely reasonable argument, from the salesman's point of view, to bring out a commercial motor-vehicle—say of 3½-ton capacity—and truthfully to represent to an intending purchaser that, although a state fixed that rating, in reality that particular commercial vehicle, on account of superior construction, could carry 4 tons with perfect economy and safety. So the state administrator had to meet this situation. He met it by requiring the minimum and the maximum rating on each commercial vehicle, so that a purchaser might still buy the 3½-ton vehicle referred to for the carrying of a 4-ton load but, before he registered it for 4 tons, the state administrator in whose jurisdiction it was to be used required the maximum rating from the builder that would cover the 4 tons.

The evolution of the foregoing principle brought about the final result that any user of a commercial motor-vehicle may register it for the minimum or for anything under or including the maximum load, and the law has been fitted to this situation so that a man may now load any commercial vehicle to its "registered capacity," as it appears on his registration certificate. The main reason that such a law is an essential as an expression of public policy is that all the safety equipment of a commercial vehicle is adjusted by the builder to his rated or guaranteed load with a "margin of safety." This margin of safety obviously must be kept inviolate. Methods and means for weighing vehicles and loads are indicated in Figs. 3 and 4.

Administrators in the East have been beset by commercial-vehicle owners who want to have an "enforcement leeway," so-called. Such owners represent that, in the loading of many commodities such as furniture and other loads consisting of differing units, it is impossible to tell within a reasonable amount just where an overload begins. So it has been a frequent occurrence for traffic men connected with large-production goods-manufacturers to request of a state that a reasonable leeway be allowed in enforcement. At first glance, this appears to be a first-class argument. It has been responded to in the past through interpretation by the police; that is, where it seemed to a policeman that there was a possible excuse, the operator or owner was given the benefit thereof. Arrests and convictions have been had in many jurisdictions; but, in a general way, it can be asserted positively that arrests have been made only in extreme cases where no misunderstanding was possible.

But the principle of allowing a "leeway" is a dangerous one and cannot be tolerated. In interpretation, should it be allowed, it would mean that the traffic men would add the "leeway" to the load and make a new maximum. Enforcement of the loading law, at least in the Eastern States, is becoming more and more severe in both of the phases mentioned, the total road-limit and the registered-capacity limit. Both kinds of overloading must be stopped. No reason exists for allowing them. Transportation engineers and superintendents must recognize that a motor vehicle purchased for the transportation of commodities must be counted on to carry only its authorized load. Administrators throughout the United States can be relied upon to understand more and more that this particular feature of motor-vehicle transportation is one of exact determination, and that it is essential from the standpoint of prevention of undue wear-and-tear and damage to highways and from the standpoint of safety. Damage to highways and delays to pay-loads are illustrated in Figs. 5 and 6. A loading within legal limits is shown in Fig. 7.

Motor-Vehicle Taxation

In conclusion of the subject of loading from the standpoint of vehicle capacity, it has been considered seriously in the past that the methods and the rates of taxation

FIG. 6—DELAY AND DAMAGE DUE TO OVERLOADING
An Example of Delayed Delivery of a Pay-Load and of Serious Damage to a Suburban Roadway Caused by Abnormal Loading of a Motor Truck in the Spring Season in Connecticut

of commercial motor-vehicles, and especially of large ones, are inequitable and unfair because the rates on some of the larger commercial-vehicles are so great as to seem to be a penalty. A plan for building up a new system of motor-vehicle taxation, on the basis of gross weight, which shall include a complete schedule of all the cars on the highway, is looked upon with some favor and, probably, will soon receive critical analysis and possible adoption. A feature of the commercial motor-vehicle carrying-trade which is suffered by some of the smaller States that have large neighbors, such as Rhode Island, Connecticut, Delaware and others in similar geographical position, is that which is characterized as interstate traffic by motor vehicles.

In Connecticut, for example, through transport lines from Massachusetts to New York and vice versa are operated. Under recent decisions in the United States District Court, covering interstate-commerce cases, the principle has been broadly set forth that a state cannot impose upon registrants of other states engaged in interstate commerce any regulation that it does not equally impose upon its own registrants. So a state would not be able to tax these interstate-commerce carriers except by means and through processes that are equally employed against its own residents and registrants. This leads to considerable hardship. It means that registrants of other states who drive commercial vehicles of the heavily loaded types mentioned through one of these smaller states can take advantage of the reciprocity law, whatever that may be; and, provided that the capitalization of the company is big enough to support enough trucks, there is no reason that such an interstate-commerce carrier may not perpetually pass through such a state without the payment of any substantial sum. When it is realized that such a carrier, being in the business of passing through and doing it systematically and consistently, does actually commit wear-and-tear on the highways to a much greater extent than any registrant within the state, it can be seen that here is a situation which makes for injustice in taxation.

In the future, it unquestionably will be a duty of each administrator of a state where interstate traffic exists to attempt to get from each legislature sufficient control to receive adequate pay from this type of commercial motor-vehicle. In its application to such vehicles, the loading law is an exercise of the police power and can be enforced irrespective of where the car is registered. It is a rule of constitutional law that a state may do whatever is required for the regulation of traffic for safety and convenience in the exercise of its police power. To summarize,

(1) Loading is considered from two viewpoints, those of total road-load and of loading to registered capacity, in relation to wear-and-tear on highways and to safety
(2) The "leeway" principle is a dangerous one
(3) Interstate traffic creates hardship under existing laws

INTRASTATE AND INTERSTATE MOTORCOACHES

Within a comparatively short period of time a new method of passenger transportation by motor vehicle has come rapidly into the foreground. This is the transportation of passengers by "bus," so-called. In almost every state, curtailment of railroad-train service has caused a demand for a more convenient and frequent means of transportation between cities and large towns. To meet this situation and commencing about 1921, organizations to run motorcoach lines have been formed. In a general way, no attempt was made by any state to regulate these upon their organization, except that most states recognized at once the necessity of requiring some larger license fee from this type of passenger-carrying vehicle than from others; but, with the lapse of time and the great success of the project, it has become necessary in many jurisdictions to establish regulation of such a nature that, in justice to the persons to be carried and to those persons who might be in competition with the carrier, and more specifically in justice to railroads, each shall have effective control. Consequently, laws have been adopted all over the United States that specify regulation of the vehicles employed in this type of motor-vehicle transportation. By these laws routes, speeds, stops and schedules are determined by some state department that considers and decides on the basis of a certificate, in the character of a charter, often stipulating exactly what the operation of the line must be, the equipment and details, the running schedules and, in general, giving out a complete supervisory decree under which the line must operate.

The regulation adopted has in general proved effective and inexpensive. One serious criticism of it is that the decree which states the various limitations of a motorcoach line is determined principally from the standpoint of transportation, and the traffic desirability of the vehicle is not sufficiently considered. The motorcoach is authorized and allowed on the highways as a transportation vehicle to carry a certain number of passen-

FIG. 7—LEGALIZED LOADING OF A MOTOR TRUCK
This View Illustrates the Appearance of a Commercial Vehicle That Bears a Load not Greater Than That Specified by Law

gers, comfortably and properly seated, but the determination as to what a vehicle the size of a motorcoach, with a potential and possible speed equal to that of an ordinary large passenger-car, will do to the traffic on the highway, has not been made. There seems to be no reason to expect further legislation on this subject of intrastate motorcoaches, so far as the authorization of routes, general equipment and service is concerned, but eventually some more carefully supervised exercise of the police power must be had whereby motorcoaches will be caused to run in less congested traffic. In other words, motorcoaches will be routed over highways that are not congested, even if that is a longer distance between terminals. This will have to be done for the sake of other traffic and, in the end, this will probably be a principle that can be applied also to large commercial motorvehicles along the general lines indicated under a former point. The relation between the motorcoach and traffic is indicated in Figs. 8 and 9.

The police power over the motorcoach, both intrastate and interstate, is positive and complete, but the effect of police regulation is lost because the penalties are inadequate. All that police power generally permits is regulation by prosecution of an operator. This means that its effect on the proposition as a whole is small. Where, in the case of an intrastate motorcoach, an organization has received from the state what to all intents and purposes is a franchise, the state has a hold upon the operator which can be exercised through discipline by the authority granting the franchise. When this is established the danger that any such organization will forfeit its valuable right to operate by continued mismanagement of a line will be very remote.

The Interstate Motorcoach

The interstate motorcoach as a carrier comes under the same interpretation of the law hereinbefore referred to in the discussion of interstate freight carriers. The interstate motorcoach cannot be required, under the decisions, to have the question of public convenience and necessity passed upon and, if passed upon unfavorably, to be excluded from a state, because the theory and practice of interstate commerce is to allow freedom for the citizens of one state to pass through another; so that the limit as to what may or may not be done in the restriction and management of the interstate motorcoach engaged in carrying passengers in the state seems to be closely determined. An interstate motorcoach company may unquestionably take up a passenger from inside a state and carry him to any point outside, or may pick

Fig. 8—The Motorcoach in Its Relation to Street Traffic
On Account of Its Size and Great Possible Speed, the Activities of the Motorcoach Should Be Regulated, Special Consideration Being Given to the Traffic Conditions on Each Highway on Which It Is To Travel

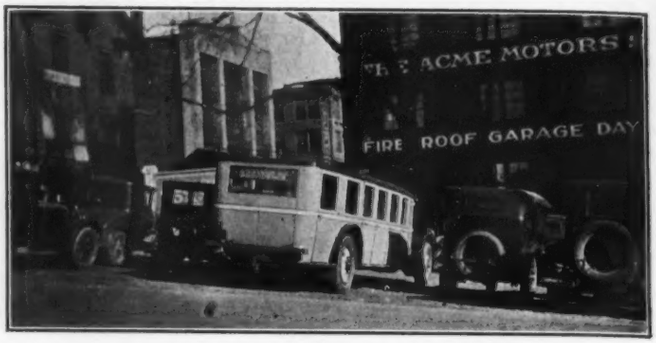

Fig. 9—Effects of the Motorcoach on Traffic
Another Phase of the Traffic Conditions to Which the Motorcoach Needs To Be Adjusted Is Illustrated in This View

up a passenger outside a state and carry him to a point inside, or may carry a passenger through a state; but it is not interstate commerce for one of these interstate vehicles to pick up a passenger within a state and deliver him to another point within the same state. Police regulation will act in this latter case. It also seems entirely feasible and right and in line with decisions that, while a state may not determine what vehicles may or may not come into a state, yet it is within the police power of a state to make reasonable regulations as to where such vehicles may go, so that in the future it is probable that interstate motorcoaches will be routed. Such steps would have been taken earlier as a solution in certain of the states if the situation had been foreseen early enough to secure the power under statutory law to do these acts as a part of the exercise of the state's police power.

It has been thought necessary by some writers and lecturers on this subject for each state to go to Congress to receive an enabling act for the management of interstate vehicles. It seems entirely clear to me that no need exists for any United States legislation unless it should prove necessary in the future to limit the number and character of the vehicles themselves. So far as the operation of the vehicles within a state is concerned, provided no unusual discriminatory regulation occurs and the regulation itself is in the exercise of police power and treats all the vehicles of similar classes alike, it would seem possible to accomplish everything needed through state laws.

The motorcoach, in general, is a traffic-vehicle that, on account of its size and great possible speed, creates a tremendous hazard on the highways. It ought not to be permitted to run at will, but should be regulated and have specifications carefully prescribed as to all its activities, with special consideration of the traffic flow on every highway on which it is to travel. To summarize motorcoach considerations,

(1) The intrastate motorcoach is under adequate control by existing laws, but any determination of desirability for its purposes should include a consideration of the traffic in which it will run

(2) The interstate motorcoach is not controlled at all. States need new laws to authorize motorcoaches, to route them and to manage them

Speed

In most jurisdictions the measurement of what a proper speed is on the highway, is determined by the test as to what is reasonable at a given place under the conditions that exist there. The principle is summarized

in statutory direction that one may proceed at a reasonable rate of speed. Sometimes "prima facie" speed-rates are prescribed as well; that is, the statute, instead of relying upon the courts for an exact interpretation, actually provides in addition to the reasonable-rate proposition, a determination as to what shall constitute that rate. The prima facie rule is a rule of evidence. It means that where a prima facie rate is prescribed in the statute the reasonable rate that it interprets still obtains as the real basis for decisions but that, if the prima facie rate is exceeded, the burden of proof is on the person who has exceeded it.

Perhaps an example will best illustrate the prima facie situation. If the prima facie rate prescribed by law on an open highway be 30 m.p.h. and a person is arrested for driving 28 m.p.h., the burden of proof that he was speeding is on the officer who arrests him. If, on the other hand, he was proceeding at 32 m.p.h., the officer has only to prove the speed and, forthwith, the burden of proof that the speed was reasonable is on the person who was arrested.

It is common all over the United States, even where a reasonable rate of speed is the basis for towns and cities, to put up signs that usually are worded "Speed 15 Miles an Hour," or something like that, and sometimes those speeds are enforced. An interpretation of this activity is entirely simple if one remembers that the persons who in the last instance decide what is a reasonable rate of speed at any given place are the authorities who enforce it. If, then, these officials have a sign put up and the courts back up the opinion as being a proper interpretation, then to all intents and purposes that sign is a warning that the reasonable rate of speed for that particular place is as stated thereon.

Grounds for criticizing such signs exist. They usually are not expressive of the exact case because, on account of brevity, they do not indicate the whole situation. The sign ought to be worded, in effect,

> A Reasonable Rate of Speed for This Place Is Considered To Be 15 Miles an Hour.—Board of Selectmen.

If such a sign were made, it probably would not be any more effective, but it certainly would provide a better ground-work for a legal prosecution of persons who exceed that speed. Without question the reasonable-rate-of-speed law is far more elastic, far better qualified for use in court decisions and better in every way than a fixed-rate-of-speed law. Those states that have in the past had fixed rates of speed are gradually discarding them in the light of enforcement of the reasonable-rate-of-speed law in other states.

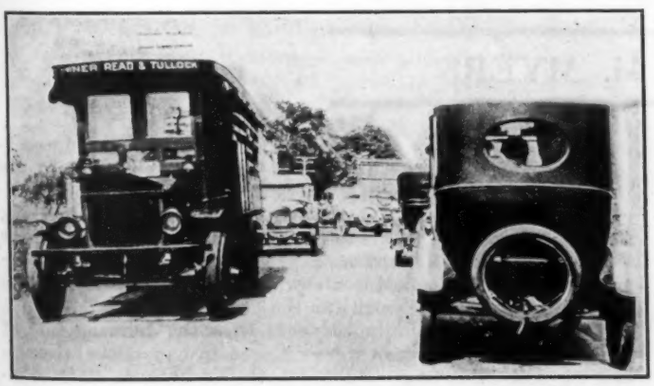

FIG. 10—CONGESTION OF TRAFFIC DUE TO SLOW VEHICLES
As a Part of a Reasonable-Rate-of-Speed Law, It Is Necessary To Consider the Slow, As Well As the Fast, Vehicle and To Make Speed Rules and Regulations So That, in the Future, Only Those Vehicles Will Be Allowed on the Highway Which Can Attain a Reasonable Traffic Speed When Everything in Connection with the Problem Is Considered

FIG. 11—THE MOTORCOACH IN ITS RELATION TO ROAD RENT
Size, Weight, Carrying Capacity and Speed Capability Are Factors That Have a Bearing on Determining Regulations Regarding What Share in Road Rental the Motorcoach Should Assume

It is sometimes claimed that, in certain jurisdictions, court convictions cannot be had under anything but a fixed-speed law. Such is still the claim in some states. If that is true, then it is because the reasonable-rate-of-speed doctrine has not been understood and applied by public sentiment. In every jurisdiction in the United States authority and direction, so far as speed is concerned, should be available to arrest for exceeding what is reasonable at any place under the conditions as they exist; and the police, the arresting authorities, the courts and all enforcement agencies ought not to be restricted by any definite and distinct rule as to what to do, by the direction of a specific speed. To have a specific speed that is illegal based on the interpretation of a statute at a fixed mileage is to invite all kinds of abuse under cover of the law. The proper form of law is to have, either with prima facie speeds or without, a broad and definite requirement for such control of the motor vehicle as will meet the emergencies of the situation in every place where the vehicle is. A reasonable-rate-of-speed law is a law following out this plan, and it will work with the highest degree of success if properly enforced in accordance with its letter and spirit.

AVERAGE SPEED

Several characteristics of speed exist which, in the light of the foregoing, might well be discussed briefly. The first might be designated as the "average rate" of speed. On highways where traffic is heavy and congested, composed of many kinds of motor vehicle, with heavy loads and without, with differing speeds and under the management of widely differentiated intelligences, the speed rule ought to be that the average speed of a line is the reasonable speed for that highway. All the vehicles in each line of traffic must travel at a uniform rate of speed. The slowest vehicle in the traffic sets the speed, and no passing from the rear should be allowed under such circumstances.

It will be understood readily that the situation which is created by such traffic is burdensome, and that it takes longer than it ought to go from one place to another. Therefore, it soon will be necessary to begin by the principles of routing, which have been hereinbefore referred to, and by prohibitory laws on the registration of vehicles not fast enough to keep up to a reasonable rate of speed to move this traffic along as a whole fast enough to make it profitable as a means of transportation. When it becomes unprofitable for certain of the slower vehicles to be maintained for processes of transportation, and where they cannot be routed over highways that are not congested, then an immediate result will be that the freight

and persons carried in such vehicles will seek some other methods of movement than highway transport.

What has been said about average speed, by the very nature of conditions, relates mainly to the very large commercial motor-vehicle. The passenger-carrying motor-coach is a vehicle that is capable of maintaining the speed of any line so that it does not enter into this particular phase of the discussion. The unwieldy, heavy, slow-moving commercial-vehicles, and the other vehicles that are not able to keep up, must be controlled by routing, by distribution or by the assignment of a time when they may travel on certain highways, which time will be when traffic on such highways is lightest.

A certain result of crowded and congested conditions is bound to be a successful attempt on the part of builders to speed up the slow-moving vehicle by better speed construction. The builder will find it necessary to place larger and larger commercial motor-vehicles upon pneumatic tires, and to develop the pneumatic-tire carrying-capacity to a point where it can sustain even the greatest loads now being carried; then, by an adjustment of the engine unit and by the construction of the whole car, to make a speedier car. Conditions of transportation are sure to demand this. The pneumatic tire is being used more and more upon commercial vehicles, and the average speed that can be attained by them is being increased. If such an evolution comes to pass, then the present slow-moving vehicle of large capacity will be used only for the carrying of unusual units of freight. The motorcoach is already the type of vehicle that the large truck probably will be as soon as transportation conditions call for its development.

A slow car on the highway is as great a highway-traffic menace as can be found anywhere. It is almost impossible to expect human nature to withstand the strain of following such a car indefinitely when it is traveling along at a lower rate of speed than the following car can easily average; so, sooner or later, an attempt is bound to be made to pass the slow-moving vehicle, creating a traffic hazard in connection with the line going the opposite way. The more congested the traffic is, the greater is the hazard. The slow-moving vehicle causes many accidents in this manner, although, more recently, the driving everywhere has improved to an extent such that the ordinary operator is not nowadays caught by such conditions frequently. It is necessary, as indicated in Fig. 10, as a part of a reasonable-rate-of-speed law, to consider the slow as well as the fast car and to make speed rules and regulations on the minimum basis so that, in the future, only those cars will be allowed on the highway which can attain a reasonable traffic speed when everything in connection with the problem is considered. Regarding speed, we find that

(1) The best speed-law is that which prescribes a reasonable rate of speed
(2) Vehicles must be capable of maintaining the average rate of reasonable speed on the highway
(3) The tendency of the situation is to evolve faster-traffic motor-vehicles of a large type

Restrictions as to Size of Vehicles

This is a subject that can be covered very briefly. Conditions of traffic have long since brought it to a head and have made it necessary in every jurisdiction to surround the larger types of vehicle with restrictions. These restrictions cover height and width. More recently, legislation has been generally passed restricting width when loaded. As necessity increases and the so-called "road rent" of a big vehicle such as that shown in Fig. 11 becomes higher, it will be natural that legislatures will restrict the size or the width limit of large vehicles even more. The tendency probably will be to throw the carrying of freight into smaller, faster moving vehicles. The condition of traffic itself will determine this, just as heretofore demonstrated in the case of the large commercial vehicle.

Conclusion

Summarizing finally, all the subject heads of this paper which deal with the present problems of administration and enforcement that are now before the states are properly subjects for standardization. The problems are becoming more, rather than less, pressing. The state's viewpoint, taking into consideration the welfare of all the people who use the highways, will demand more and more management and restriction. Engineers and builders will realize that, while the construction and building of motor vehicles is bound to follow the demand, yet that demand can be anticipated to some extent and led into a type of vehicle which is capable of average performance when considered in comparison with all the other motor vehicles. It will certainly be one essential of the traffic of the future that all the vehicles concerned in it are as nearly as possible of the same average size, capable of the necessary speed and restricted as to speed, weight, width and route.

WILLIAM M. MYERS

SPINAL meningitis caused the very sudden and unexpected death on Oct. 14 of William M. Myers, sales engineer of the Johnson Co., of Detroit. In the 10 years of his connection with the company he had not lost a day on account of sickness but was seized with a violent attack of earache at noon on Oct. 13 and passed away at 4 o'clock the next morning. Mr. Myers had been a member of the Society since March, 1921.

Born in Camden, N. J., in 1881, he was graduated from the Spring Garden Institute, Philadelphia, in 1898 with the degree of mechanical engineer after a 2-years' course of day-and-night study. His business career included 7-years' general experience in machine shops; 1 year in the engineering department of the duPont Powder Co., engaged in the installation of machinery; 2 years as manager of general engineering and experimental work for the Bell Engineering Co., of Camden; 4 years as motor-truck engineer for the H. A. Bowen Co.; 2 years as experimental and designing engineer for the Vulcan Motor Devices Co.; 2 years in designing and experimental work for the Cutler-Hammer Mfg. Co., of Milwaukee, and finally 10 years with the Johnson Co., of which the first five years were devoted to experimental engineering and designing. Subsequently he became sales engineer for that company.

Engine Corrosion—Its Causes and Avoidance

By Frank Jardine[1]

Service Meeting Paper

ABSTRACT

CORROSION in gasoline engines is generally believed to be due to sulphuric acid formed by the combination of sulphur carried in low-grade fuels and oils with water that enters or is generated in the engine. Much of this trouble occurs in winter and may be traced directly to the action of water that condenses on the inside of the cylinders and crankcase when a cold engine is started. The water destroys the oil-film and comes into direct contact with metal of the pistons, cylinders and other parts, causing them to rust. If this occurs and the lubricating system does not supply more oil to the surfaces immediately upon the restarting of the engine, scored cylinders and pistons are likely to result, or, if the engine is stopped before it is warmed up, condensation and rusting will be rapid and will result in excessive wear.

The only completely successful method of dealing with the condensation and rust problem is to provide a lubricating system that will begin to function as soon as the engine is started. The splash system has been found to meet this requirement best. If pressure-feed systems are used, it is recommended that

(1) The oil-pump be located in the sump
(2) No oil-screen finer than 30 mesh be used over the intake and it should have a bypass
(3) Oil lines be as straight and as short as possible and not less than ½ in. in diameter
(4) Connecting-rods have a diametrical clearance of 0.0015 in. and a side clearance of 0.0060 to 0.0080 in. for oil
(5) Light oils be used in winter

Road-tests have not confirmed the common belief that use of thin or diluted oils results in rapid wear of pistons and cylinders. A castor-oil film is more resistant to the action of water than a mineral-oil film and it is suggested as an inside coating in engines that are stored during cold weather.

CORROSION in gasoline engines can be traced, in practically all cases, to condensation of the water vapor in the gases of combustion and of moisture in the air upon the cold surfaces of the cylinders and crankcase walls. It is found in the form of rust in crankcases and cylinders and is made evident by etched wristpins, valve tappets, timing chains and other engine parts.

The most commonly accepted theory for the cause of corrosion is the action of sulphuric acid, which is formed by the combination of sulphur in the fuel and lubricating oil with water entering or generated in the engine. According to A. Ludlow Clayden, water collects in the engine at the rate of 80 cc. per hr. at zero temperature. The rate at which the sulphur collects would, no doubt, depend largely upon the sulphur content of the fuel and oil used. Sulphuric acid as a corrosive agent will not be dealt with in this paper, which is concerned only with water, its sources and effects, and means of avoiding its presence or of neutralizing its effects.

[1] M.S.A.E.—Engineer, Aluminum Co. of America, Cleveland.

How Water Gets Into the Crankcase

Water may enter the crankcase of an automobile as a result of blow-by of the gases of combustion past the pistons and by condensation of the water vapor on the walls of the crankcase. In the present design of internal-combustion engines it would be difficult to eliminate either of these causes entirely but conditions can be improved considerably.

Ideal conditions for condensation exist when starting a cold engine, namely, hot moisture-laden products of combustion in contact with cold metallic cylinder-walls. The water thus formed literally runs down into the crankcase until the temperature of the cylinder-walls rises above 110 deg. fahr., when condensation ceases. Condensation is practically negligible in the warmer months and, if a small quantity of water is condensed, it will be evaporated rapidly at the higher temperature that is quickly reached by the engine. The period of condensation in an engine that is started at a temperature of 10 deg. fahr. has been shown to vary between 2 and 10 min., the time depending upon the design of the engine and particularly upon the size and the type of the cooling system used. Condensation proceeds for a considerably longer time but at a much slower rate in the crankcase and on the cams, tappets, timing chain and other metallic parts that are in contact with the warmer atmosphere.

It has been found by close observation that the water rarely collects in large quantities. It appears in fine globules about the size of a small pin-head and takes considerable time to collect. The crankcase proper usually becomes warm enough, when the car is operated in winter, to keep it free from ice except under the most extreme weather-conditions, but the pan often becomes lined with ice from the oil level to the top of the pan. This ice melts sooner or later and the water finds its way into the oil. If the fine drops of water freeze in the oil, they gather into a solid mass around the pump screen.

Destroys Oil-Film and Attacks Metal

The effects of water deposition and means for combatting them, particularly as related to pistons and cylinders, have been the subject of extensive study in the laboratories at Cleveland of the company that I represent. The first effect, which is aided by the presence of large quantities of raw gasoline due to excessive use of the choke when starting, is to destroy the oil-film that remains on the cylinder-walls after the engine was last stopped. This allows water to come into contact with the bare cylinder-walls and, unless the lubricating system delivers fresh oil to these parts immediately upon the starting of the engine, severe wear or scoring of the pistons and cylinders will result. If the engine is stopped after a minute or so of running and before the

cylinder-walls have warmed up or before any fresh lubricant has been supplied, the water remaining in contact with the walls will cause rusting. Rust will cover the cylinder-walls in a remarkably short time and will act as an abrasive when the engine is started again. We have discovered instances in which the cylinder-walls were completely covered with rust in less than ½ hr. and, in one exaggerated case when water was used in the crankcase instead of oil, the pistons rusted so tightly in the cylinders within 10 min. after stopping the engine that they had to be driven out.

Prompt Supply of Fresh Oil Needed

The only method that we have been able to discover for successfully combatting the destruction of the oil-film by water condensation is to supply fresh oil to the surfaces at least as fast as the water gathers. This method has been uniformly successful in all cases but its application has been exceedingly difficult in a few cases. Conditions can be improved by using short water-jackets, by steam-cooling, by thermostatic control of the cooling-water circulation or by the use of radiator shutters to raise the temperature of the cooling-water above 110 deg. fahr. more rapidly.

The problem of assuring a quick and positive oil-supply involves many complications. The old-fashioned splash-system of lubrication to pistons and cylinders is the simplest, surest and cheapest method of accomplishing the object that has been developed. It will supply oil to the pistons and cylinders immediately upon starting the engine, regardless of temperature or of the viscosity of the oil. We have found that engines in which this system is used are uniformly free from cold-weather lubrication troubles and from rust. The full-pressure system of lubrication may be rendered completely inoperative for periods of from 5 to 15 min. on a very cold day. This time has been determined by setting up various engines in a refrigeration room and turning them over with a dynamometer at 1000 or 1500 r.p.m., after having removed the cylinder-heads and cut a section out of the pistons so that the instant any oil reached the cylinder-wall it could be seen.

Pressure-Feed Slow in Cold Weather

If water builds-up in the oil-pan, as it will do when an engine is given a series of short low-temperature runs at comparatively long intervals, ice may form around the pump inlet-screen and block it indefinitely. Many cases of burned bearings have resulted from this. If the oil is fresh and of medium or heavy grade, it will not pass through the ordinary pump-screen at a temperature of 10 deg. fahr. or lower. If the oil-pump is located high on the engine, as on the end of the camshaft, it will not lift cold viscous oil out of the sump. If connecting-rod bearings are smooth and are fitted to less than 0.0015-in. diametrical clearance and 0.0060 to 0.0080-in. side clearance, it will be found practically impossible to force cold oil through the bearings at any pressure. We have fitted a plain grooveless connecting-rod to a crankpin, using the clearances mentioned and connecting the bearing to an Alemite grease-gun and a pressure-gage. Using straight Mobil A at 0 deg. fahr., a pressure of 500 lb. per sq. in. failed to force any oil through the bearing in a period of more than 15 min. However, conditions were much improved when thinner oils were used, although the 0.0015-in. diametrical clearance and 0.0080-in. side clearance were still necessary to allow it to pass.

We have tried many methods for overcoming the sluggish operation of pressure lubrication-systems at low temperatures. These have included direct feed to the pistons and cylinders, the grooving of connecting-rod bearings and the drilling of connecting-rods to permit the oil to escape more easily. These means, however, all depend absolutely upon the functioning of the oil-pump and oil-screen and carry with them the danger of over-oiling in warm weather. Finally we have come to the decision to make the following recommendations, which, if followed, will be found to deal effectively with the cold-weather lubrication problem and without involving any danger of over-oiling in warm weather:

(1) The oil-pump should be located in the sump, preferably in the center of the engine
(2) If a screen is used to cover the oil intake, it should not be finer than 30 mesh and should be provided with a by-pass that will allow direct suction from the sump in case the screen becomes clogged with ice
(3) All oil-supply lines should be as straight and short as possible and of generous diameter; oil pipes should be ½ in. in diameter and crankshaft ducts should be at least 3/16 in. in diameter
(4) Connecting-rods should have no less than 0.0015-in. diametrical clearance and 0.0060 to 0.0080-in. side clearance
(5) Light oils should be used in winter

Thin Oil Does Not Result in Wear

Direct control of the kind of oil used in winter is, of course, out of the hands of the car builder, but he can do considerable through his service-stations to bring about a more general adoption of the practice on the part of the public of using light oils in cold weather. Many engineers believe that the use of thin or highly diluted oils will result in excessive wear of the pistons and cylinders, if not in their actual scoring. Our tests have not indicated that this is so. We ran one road-test of 5000 miles, much of which was at speeds of 40 m.p.h. and over, using a 50-50 mixture of kerosene and Mobil A in the crankcase. The preceding 5000 miles had been run under the same conditions except that straight Mobil A was used. In each case the oil was changed after each 500 miles. The total amount of cylinder-wear for the run in which kerosene was used averaged 0.00025 in., while for the run with straight Mobil A the wear was 0.00050 in. by actual measurement. I do not mean to imply by this that the thinner the oil the less the wear, but only to show that thin oil will not result in seizure or excessive wear. We would prefer thin oil to no oil at all.

Use Castor-Oil in Stored Cars

A few words about corrosion of engines that are held in storage during the winter may be of interest. Ordinary temperature-changes from day to day are sufficient to produce considerable condensation on the inside of crankcases that are exposed to such changes. It has been found that ordinary mineral-oil films are destroyed rather quickly when in contact with water, with consequent rusting in proportion to the amount of water present and to the time of exposure of the metal to the water. If, however, castor-oil is used, the film is much more resistant to the action of the water and the rust that does form is little more than a coloration of the surface rather than definite corrosion, as when mineral oil is used. Castor-oil cannot be used, of course, for automobile engines when driving, because of its tendency to become sticky, but it should be of value when engines are to be stored for a considerable time in cold weather.

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Coordination of Railroad and Motor Truck in Freight Handling

By Joseph L. Scott[1]

Automotive Transportation Meeting Paper *Illustrated with* Photographs

ABSTRACT

TWO years ago the Pennsylvania Railroad Co. contracted with a Philadelphia general haulage firm to demonstrate the handling of less-than-carload freight by motor truck. Two operating units were placed in service in a very congested traffic territory on the main line and the experiment proved so successful during a 3-months' period that additional operating units were installed on the Maryland, Trenton, New York and Atlantic divisions. The Trenton division is now entirely motorized for the handling of less-than-carload freight.

Uninterrupted daily truck-service is now given to 469 cities and towns in the four States of Pennsylvania, New Jersey, Delaware and Maryland and deliveries are expedited by from 24 to 48 hr. in some cases. Truck-masters and their helpers travel from 50 to 125 miles daily and handle from 20,000 to 60,000 lb. of freight. The cost per ton-mile for trucking varies from 3 to 10 cents according to the territories in which the trucks operate.

From observations and its own experience, the haulage firm believes that the economic haul for a motor truck is from 50 to 75 miles a day, that further coordination between railroad systems and motor-trucking companies will occur, that all motor vehicles engaged in common-carrier service should come under state or federal regulation, that no one should be allowed to operate a motor vehicle as a common carrier who does not have proper financial standing and does not carry insurance to protect the shipping public, and that motor-truck builders should see to it that their product is placed in the hands of only competent and responsible operators.

[1] Scott Bros., Philadelphia.

IN September, 1923, the Pennsylvania Railroad Co. selected Scott Bros., who have been engaged in the general hauling business since 1868, to demonstrate the handling of less-than-carload freight by motor truck between Overbrook and Downingtown on its main line. Two units were placed in service in this experimental operation, with truck-masters and helpers. In selecting this division for the operation, the railroad company chose a territory having continuously heavy traffic, extremely complicated conditions for the handling of less-than-carload freight, and one of the busiest sections of railroad in the Country. Incidentally, more railroad officials were watching this operation than were watching any like undertaking in any other part of the Country. The trucks operated over a route 32 miles long and served 27 towns and 28 stations.

After this operation had proved successful for a period of 3 months, the railroad company realized the possibilities of the motor truck in connection with less-than-carload freight-handling, and installed additional units on the Maryland, Trenton, New York and Atlantic divisions. Of these, the Trenton division is now entirely motorized for the handling of less-than-carload freight.

An uninterrupted daily service is now given by our trucks to 469 towns in the States of Maryland, Pennsylvania, New Jersey and Delaware, and the truck service is coordinated with 1348 miles of daily railroad service. This coordination has expedited delivery from 24 to 48 hr. in a number of cases. Transfers of freight from

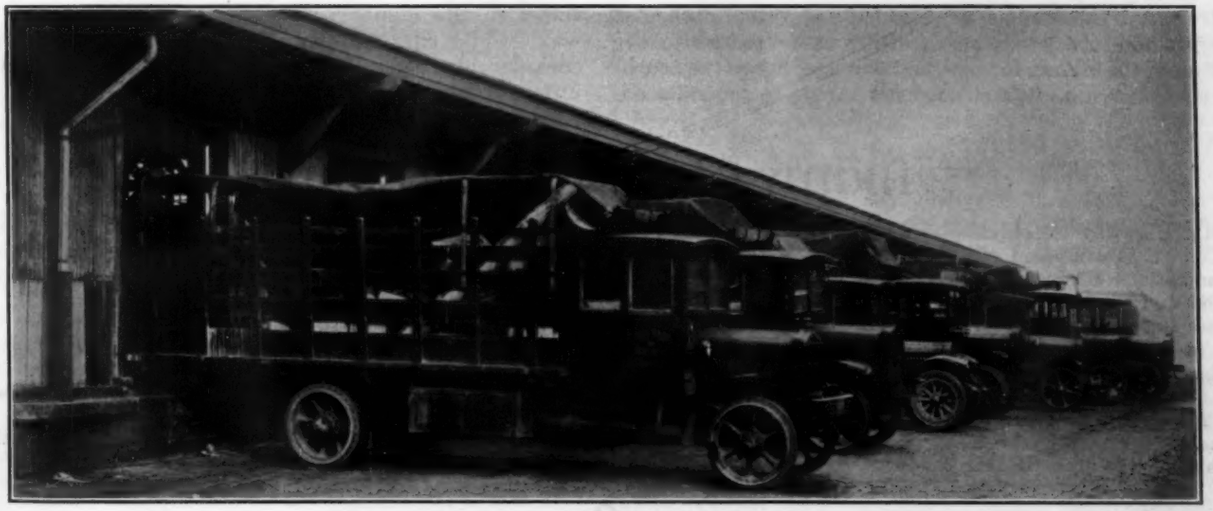


Fig. 1—Trucks at Transfer Station in Trenton, N. J.
Interchange of Less-than-Carload Freight between Railroad Cars and Motor Trucks Occurs in Both Large Cities and Small Towns. Truck Operating Units Have Been Installed on Four Divisions of the Pennsylvania Railroad and Make Daily Deliveries in 469 Cities and Towns in Pennsylvania, New Jersey, Delaware and Maryland

FIG. 2—LOADING TRUCKS OF ONE OPERATING UNIT AT PEMBROKE, PA.

This View Shows a Station in One of the Smaller Towns. By Such Coordination of Motor Truck and Railroad Service, Deliveries Have Been Expedited in Some Cases by from 24 to 48 Hr. The Truck-Master and Their Helpers Travel from 50 to 125 Miles Daily and Handle from 20,000 to 60,000 Lb. of Freight. The Cost Per Ton-Mile Varies from 3 to 10 Cents

freight cars to trucks and vice versa are made in large cities as well as small towns. A transfer station in Trenton, N. J., is shown in Fig. 1 and a small station in the town of Pembroke, Pa., is shown in Fig. 2.

BUILDING-UP AN ORGANIZATION

At the time this service was inaugurated, the problem of organization arose, but as our firm had been engaged in general contract hauling for more than 50 years, we were able to pick first class men from our own organization who had had several years' experience in the transportation of almost all kinds of commodities. This enabled us to render the class of service demanded by the railroad company.

The men selected to pioneer this operation took as much interest in the success of the undertaking as the railroad officials and the members of the haulage firm. Upon one occasion, one of the truck-masters dropped a roll of roofing paper and his truck passed over and damaged it. The truck-master immediately made a purchase of a like roll at his own expense to avoid a claim for damages against the trucking firm. This is only one of many such acts of loyalty.

The truck-masters and their helpers travel from 50 to 125 miles per day and handle from 20,000 to 60,000 lb. of freight divided into from 1 to 600 individual packages. They handle the goods so carefully as to reduce to the minimum the claims for loss and damage, hence the trucking service results in a substantial saving to the railroad.

The cost per ton-mile for trucking varies from 3 to 10 cents, due to the different territories that are covered. An economic haul for a motor truck is approximately from 50 to 75 miles per day, in our judgment, which is based upon observation of our general operations.

COORDINATION WILL ESTABLISH ECONOMIC TRANSPORTATION

A difference of opinion as to the advisability of co-operation between the railroad companies and motor-truck operators seems to exist, but we believe that the coordination of the railroad system with the motor truck will establish economic transportation. The objection to this plan is due to the irresponsible truck operator, who purchases motor-truck equipment with practically no investment and enters into direct competition with the railroads in long-distance hauling, making it unprofitable for both carriers. This condition is brought about primarily by the merchandising of motor trucks by their builders on a basis of practically no cash-down payment regardless of the purchaser's financial responsibility, thereby establishing irresponsible competition. In many cases the operators have no organization and no financial standing and do not carry insurance to protect the shipping public. Further, they operate illegally by overloading and do not come under any federal regulation. This permits them to carry merchandise in any manner or at such rates as they see fit to establish. Thus the railroad systems and the responsible truck operators are placed at a great disadvantage and unfair competition develops. Because of the contractual relations existing between the Pennsylvania Railroad Co. and my firm, we have been able to serve 469 towns daily without an infringement of the law.

From general observation, we have concluded that we are now in a position to predict coordination between the motor vehicle and the railroad and to assert that all motor-truck operations should come under state or federal regulation, that no one should be allowed to operate a motor vehicle in a common-carrier service without proper financial standing and without carrying such insurance as may be prescribed by law to protect the shipping public and furthermore, that the motor-truck builders should supervise the merchandising of their product to see that it is placed in the hands of competent and responsible operators. If the restrictions outlined are followed, the number of trucks that congest the highways while carrying only one-third of a load will be considerably reduced and irresponsible operators and unfair competitors will be eliminated.

HIGHWAY RESEARCH BOARD

THE Highway Research Board of the National Research Council is composed of representatives of those national organizations interested in the development of the highways of the Country. Its membership includes representatives of technical organizations, of Federal and State departments, and of higher educational institutions.

The Highway Research Board functions through an executive committee and a director, who is the executive officer of the Board. There are research committees, each assigned to a major division in highway research. In addition, the Highway Research Board conducts special investigations financed by industrial organizations. The Board furnishes unique auspices under which such work may be carried on that is scientific in character and strictly impartial in its findings.

The Board is not of itself a research agency, but serves as a national clearing-house for all matters pertaining to highway research. In making research information available, the Board always gives full credit to those agencies, or individuals, responsible for the particular research. The office of the National Research Council is in the City of Washington.

Discussion of Papers at the Semi-Annual Meeting

THE discussion of the four papers presented by C. O. Guernsey, P. M. Heldt, H. E. Maynard, and H. Clyde Snook at the 1925 Semi-Annual Meeting held at White Sulphur Springs, W. Va., June 16 to 19, is printed herewith. The authors were afforded an opportunity to submit written replies to points made in the discussion of their papers, and the various discussers were given an opportunity to approve the stenographic report of their remarks before publication.

For the convenience of the members, a brief abstract of each paper precedes the discussion, with a reference to the issue of THE JOURNAL in which the paper appeared, so that members who desire to refer to the complete text as originally printed and the illustrations that appeared in connection therewith can do so with the minimum of effort.

The discussion of the papers presented by D. P. Barnard, 4th; Earle Buckingham; Otto M. Burkhardt; J. R. Cautley and A. Y. Dodge; A. Ludlow Clayden; and John O. Eisinger was printed in the November issue of THE JOURNAL. The discussion of the paper by Henry S. Baldwin entitled Electric Drive for Gasoline-Propelled Motorbus will, it is hoped, be available for publication in an early issue.

REQUIREMENTS IN GASOLINE RAIL-CAR DESIGN

BY C. O. GUERNSEY[1]

ABSTRACT

VARIOUS efforts have been made to apply the internal-combustion engine to self-propelled rail-cars. The greatest development along this line prior to the war was in connection with the McKeen and General Electric cars that were built from 1906 to 1914. The builders of those cars were greatly handicapped by the lack of available experience in connection with the design of gasoline engines, particularly of the larger type. Since the war a gradual development of rail-cars has taken place, starting with small converted motor trucks and gradually increasing in size and adaptability to the service, until now gasoline-electric cars of 250 hp. and about 75 ft. in length are available, while mechanically driven cars are available up to 190 continuous horsepower.

Each of the various drives that have been proposed, including hydraulic, electric and mechanical, has various advantages, but it seems probable at the present time that the gasoline-electric system will be used generally in cars of extremely large size, while the straight mechanical drive will be preferable for cars up to about 200 hp. The advantages and disadvantages of the different types of drive are given and the service conditions and design requirements to be met by rail-car construction are listed in this paper. The gasoline rail-car must be designed for utmost reliability, durability and simplicity of operation and maintenance. The powerplant and transmission design and the work characteristics of the largest present mechanically-driven rail-car are described and its operating costs as compared with those of light steam trains are given. Cars of this type fill a distinct economic field between the highway motorcoach and the steam locomotive and train. A limited potential market for the sale of about 230 to 250 cars per year exists.—[Printed in the July, 1925, issue of THE JOURNAL.]

THE DISCUSSION

R. MCA. LLOYD[2]:—How are the cars heated?

MR. GUERNSEY:—They are heated by a coal-fired hot-water heater similar to the old-time Baker steam-train car-heater.

MR. LLOYD:—Is it not possible to obtain enough heat from the exhaust?

MR. GUERNSEY:—Not for the normal climate in this Country. Often a train must wait at a station for an hour or two to meet some main-line train, and, even when the engine is kept idling, the heat is not sufficient to keep the car warm.

J. C. THIRLWALL[3]:—Mr. Guernsey has described the field of the rail-car and has given a fair comparison of the advantages and disadvantages of the electric and the mechanical drives, but some of the advantages that he touched upon might be elaborated upon to advantage from the standpoint of the manufacturer of electrical equipment.

We know that the weight and the first cost of the electric drive are inherently greater. Probably the efficiency of the mechanical drive is somewhat higher after reaching the third, fourth or fifth speed-gear positions, but I doubt if it is as much as Mr. Guernsey stated. No one seems to know exactly what the efficiency of a train of gears is. Stand-tests show certain results. In service, after the bearings have become somewhat worn, the alignment is then not so perfect as it was at first and, since lubrication varies under different conditions of climate and of maintenance, the service efficiency on the trains of gearing in actual operation probably is considerably lower than it is on the stand-tests.

On the other hand, the efficiency of electric transmission varies only slightly with age or with any conditions that may develop during the life of the equipment. Moreover, I do not believe that the difference between the two types of drive can be expressed by the relative mechanical efficiencies because, on any gear-ratio with mechanical drive, the speed and horsepower of the engine must vary with the car-speed and therefore it is impossible, whatever the efficiency, to obtain the full horsepower of the engine throughout the entire range of acceleration. In the electric drive, however, since the engine-speed and the car-speed are entirely independent of each other, it is possible to obtain the maximum engine efficiency throughout the cycle of acceleration.

Another point is that, when the mechanically driven rail-car, on any of the final gear positions, strikes a decelerating grade, the speed of the engine is still tied to

[1] M.S.A.E.—Chief engineer, automotive car division, J. G. Brill Co., Philadelphia.

[2] M.S.A.E.—Consulting engineer, New York City.

[3] M.S.A.E.—Engineer, railway engineering division, General Electric Co., Schenectady, N. Y.

the car-speed, and the engine, driven by the wheels, becomes a gasoline pump when power is not required and, instead of driving the car, is simply wasting fuel in keeping the engine-speed up to that of the car. With the electric drive, the throttle can be closed so that the engine will develop only sufficient power to maintain the desired car-speed under any set of conditions.

Reliability Is Most Important

The most important point, however, is the reliability which Mr. Guernsey emphasized and which I believe has the greatest appeal to the railroad man in the long run. We know from more than 30 years of experience that the electric drive on city and interurban electric cars is the most reliable and the longest-lived part of the entire car equipment. We have countless records of service on trolley-cars in this Country that show that after from 10 to 15 years of operation, and in some cases as long as 20 years, the maintenance of the entire electrical equipment on large heavy cars that are comparable with those described by Mr. Guernsey averages less than 1 cent per car-mile. In many services, as in the New York City subways and the Hudson & Manhattan tubes, it averages only about 0.6 cents per car-mile. We never have been able to obtain any records of mechanical transmissions that approach these low costs even in the first few years of operation. The mechanical-drive car, as shown in the drawings, requires four propeller-shafts, eight universal-joints, a set of change gears and two sets of bevel-gears. The electric drive requires only two spur-gears. Spur-gears on electric cars operate in many cases as many as 1,000,000 miles with almost negligible maintenance. It seems very doubtful that any system of change gears, as used in mechanical drive, can even approach such a mileage. The final test might be deduced from some of the historical references made by Mr. Guernsey. Between 100 and 125 McKeen rail-cars with mechanical drive were put out about 15 or 18 years ago and the General Electric Co. turned out 88 gas-electric cars. Of the 88 that were sold at that period, approximately 60 that we know of are in active service today. So far as we can check, none of the McKeen cars is being used actively at this time. Very few of them are even in service and some of the electric drives that the General Electric Co. has sold in the last year are being put into some of the old McKeen cars on which the original mechanical-drive equipment had worn out completely.

Mechanical Drive 90 Per Cent Efficient

Mr. Guernsey:—It is true that the electric-drive car can run at the full power of the engine at all times. With our mechanical drive the engine runs at from 900 to 1300 r.p.m. at all times in regular service. So far as starting the car is concerned, the mechanical drive can beat the electric drive. At 900 r.p.m. the engine delivers 138 hp., and at 1300 r.p.m. it delivers 190 hp. Taking the power-loss factors, it would deliver, at 900 r.p.m., about from 114 to 120 hp. to the rail with a car weighing 55,000 lb. The gas-electric car, with an engine of the same size, would deliver 131 hp. to the rail as the maximum, whereas, with the mechanical drive, the maximum of about 170 hp. can be delivered with a car weighing 55,000 lb. as against an electric-drive car weighing 74,000 lb.

Regarding the action of the engine as a gasoline pump when running down grade, the engine can be operated, without going beyond governor speed, at any speed at which any car should reasonably be operated. If no power is needed, the clutch can be disengaged.

The implied comparison of the McKeen mechanical-drive car with the present mechanical drive is not very pertinent. To use a two-speed transmission in an automobile of the present day even with the automobile's very high power-factor would not be considered good practice. Imagine doing that in a class of equipment in which the power-factor at top speed is only about 20 or 25 lb. per ton. I believe that the mechanical drive that involves a suitable ratio for a steep grade and a suitable ratio for straight-away operation on level track, with possible continuous use of any of those ratios, should not be compared with the earlier drives.

As for efficiency, the electric drive requires two trains of spur pinions and gears, one pair of gears from each motor to each axle. In the mechanical drive the drive to the two axles is through bevel-gears instead of spur-gears and the gears are mounted on roller bearings instead of plain bearings. Moreover, a single reduction is provided in the transmission through helical spur-gears running on roller bearings to lap gears, both gears carbonized and hardened and running in oil, hence I am sure that actual experience will bear out what we have learned by calculations and tests, namely, that the efficiency can be kept at 90 per cent or better.

Distinct Fields for Both Types

T. V. Buckwalter[4]:—The McKeen car was developed under tremendous disadvantages. A suitable internal-combustion engine was not available when it was brought out and the transmission had only two speeds, so that when the comparatively heavy car was accelerated on low-speed and then stepped-up into high-speed, the change from starting-speed to running-speed was so great that the engine could not handle the load. Under certain conditions of grade it would run in high at only about 300 or 400 r.p.m. with a wide-open throttle. The impulses could be counted by the knocking in the cylinderheads. That inability to accelerate in direct drive was one of the great weaknesses of the car.

Some problems may have to be worked out as to the life of gearing and other component parts but I think they will be solved in time and that a distinct field will be found to exist for each type of car. A test has been made within the last few months of heavy railroad equipment that the company with which I am connected is trying to help the railroads develop. One car out of an order of 1000 identical box-cars operating on one of the Middle Western railroads was equipped with roller-bearing axles and it has been operated right along in the same service with the other 999 cars. The bearings have now been run about 25,000 miles very successfully. In a comparative test made recently with the roller-bearing car and one with plain bearings, both of which had been operated for a year and which had traveled about 25,000 miles under identical conditions, some interesting facts were developed. The test was made on the electric railroad between Canton and Akron, Ohio, and a small electric-locomotive was used for drawing the cars. The power consumed, in volts and amperes, as indicated on an integrating wattmeter, was noted at 10-sec. itervals. Elements of appreciable error were introduced, because of stops for crossings and numerous other things, but the indications were that a power saving of about 12 per cent was effected. That, in itself, is not very great but, in measuring the starting resistance, with a start and a stop every 10 ft., it was noted that the roller-

[4] M.S.A.E.—Chief engineer, Timken Roller Bearing Co., Canton, Ohio.

bearing car required a pull of a little less than 300 lb. to start. The weight of the car was a few hundred pounds over 61 tons. The car with the plain bearings, fully run-in, required a little more than 2400 lb. The ratio is 1 to 8. These tests appear to indicate that the gas-electric car will find its most fertile field in services requiring frequent starts, while in services with runs of comparatively long distances, probably not less than 1 or 2 miles but certainly under 5 miles, the mechanical-drive car will operate more economically because of its lighter weight and its higher efficiency.

If you will look through the records of the Society, you will find a description of a gas-electric locomotive or tractor that was designed about 1912 and that was much like one of the gas-electric cars described in Mr. Guernsey's paper except that it had a smaller engine and operated on the highway. It had four-wheel drive, four-wheel steer and four-wheel brakes. Seven of these machines were built and all are operating still under very severe conditions. They operated about 24 hr. per day during the war, handling nearly all of the manganese that came into the Country.

Traffic Tendency Is Toward Motorcoaches

R. E. Plimpton[5]:—The paper has given the impression that the rail-car has a future in general branch-line service, but the information I have gained is that most of the branch lines have such light traffic now that even the rail-car could not be made to pay. Of course, the term "branch line" is rather indefinite. A branch may vary from a stub 2 or 3 miles long to a pair of tracks 200 miles in length. If a rail-car is operated on Mr. Guernsey's figure of 45 cents per mile, an average of 30 passengers at a fare of 1½ cents per passenger-mile would be required to pay the operating expenses on each trip. These 30 passengers represent about 2000 passengers a month, assuming that one round trip is made daily. Suppose, however, that the rail-car carries an average of 500 passengers a month. The income will then drop to about 11 cents per mile and the fare will have to be increased to 6 cents per passenger-mile to pay the cost of operating under conditions frequently experienced in serving rural territory. Then, as a matter of economy, passengers probably will take to the motorcoach or to riding in their own automobiles.

The main reason that the railroads want to use rail-cars is that they are trying to make branch lines pay a profit. They are not trying to cut down the losses. If they could operate for 45 cents per mile on some of the branches, they could cut down the losses considerably, but on many of them they could not pay even for the maintenance of way.

Some of the branch lines that have been abandoned by the large railroad systems are being operated as community roads with light rolling-stock. The local banker and merchant act as officers of the company without pay. Such companies are not financially able to maintain the track. They do not have the technical operating talent that has been found necessary on the successful rail systems and I do not believe they will last long. Such operations have been entered into usually where the communities do not have good highways.

I think that a great part of the branch-line traffic will have to go to the highways. These communities that are spending money in the attempt to keep converted or make-shift motor trucks in operation on rails, or that are paying lawyers to fight the abandonment of these branch lines as proposed by the railroads, would spend that money to much better advantage if they would put it into good motor-transportation companies. I have seen country motorcoach lines that can operate fairly well for from 15 to 20 cents per mile. That is not true of a city line and the country motorcoach lines do not give the same service and comfort as the city lines, but at least they supply frequent transportation. They can make four trips a day whereas, on most of these branch railroads, only one round-trip per day is made.

The New York, New Haven & Hartford Railroad, which furnishes an outstanding example of an attempt to supply transportation with rail-cars in sparsely settled districts, has not done it by furnishing frequent service on any one line. It is fortunate in having a network of branches so that a car makes 150 or 200 miles per day, which is necessary to reduce the operating cost to 45 cents per mile. The cars have to zigzag back and forth. Each community gets only one trip per day and may not get that at a convenient time. Only this morning I learned that the New Haven Railroad has recently taken out incorporation papers for a company to operate motor vehicles over the highways, and has thus admitted the need of such a service.

The operating cost of 45 cents per mile mentioned by Mr. Guernsey seems unusually low for a large vehicle such as his Model 75, either with or without a trailer. If it were operated by one of the large systems that have to pay the high wages of the railroad brotherhoods of employes, the company would have difficulty in getting the cost down to that figure. It would have to pay for overtime very frequently, and for layover time to hold its men. It is doubtful if the costs could be kept down under such conditions, although this might be possible on some of the short lines where the high wage-scale of the brotherhoods is not in force.

Rail-Cars Replace Light Steam-Trains

Mr. Guernsey:—I am glad that Mr. Plimpton mentioned cost, because he apparently has the wrong impression and perhaps others have, also. The cost of 45 cents per mile that I gave is for the Model 75, the 190-hp. car, and its trailer, a total loaded train-weight of 120,000 lb. and a total capacity of 165 passengers in addition to 4 tons of baggage. It is not fair to compare that kind of equipment with a 25-passenger motorcoach. That train will replace, on a main line or a branch line, any local train that consists of the usual small locomotive, a combination baggage-car and smoker and a day coach. The smaller rail-cars, as for instance the 70-hp. car, which seats 38 passengers and will carry 4000 lb. of baggage, have been operated on short-line railroads for more than 200,000 miles at a cost of 17 cents per mile, including all charges, such as depreciation, maintenance, interest, fuel, crew hire, and everything else that goes into the actual operation of the equipment.

That low cost cannot be obtained on the large systems where brotherhood rates of wages are paid. The Chicago Great Western Railroad has operated one of those 70-hp. cars for about 3 years and for a distance that I should estimate at perhaps 120,000 miles, at 26 cents per mile. That cost does not, however, include interest on the investment, which would bring the cost to about 30 cents per mile, which is a fair figure for that car in regular service.

Whether the railroads buy these rail-cars because they can make a profit with them or because they can cut down losses depends upon circumstances, as each case is different, just as every motorcoach application differs

[5] M.S.A.E.—Associate editor, *Bus Transportation*, New York City.

from others. Speaking generally, the initial purpose in buying equipment of this class is to reduce losses on runs that the railroads are forced by public demand and the regulating bodies to continue. However, it has been found that runs that previously showed tremendous losses have built-up traffic and at the same time reduced costs to the point where many branch lines have become profitable for the first time in their history. I have in mind a short-line railroad in Texas that, 2 years prior to purchasing gasoline rail-car equipment, applied for a receivership to secure a court order permitting it to discontinue passenger service. Its losses were $40,000 per year on that service alone. It put on one of the 70-hp. gasoline cars and made a net profit the first year of $22,000, or a clear profit of $5,000 above the purchase price.

E. R. JACKSON[6]:—The company with which I am associated has been building engines for rail-car service and a number of installations of these engines has been made. It may not be amiss to mention a number of closely allied types of equipment that are driven by gasoline engines. The Arthur G. McKee Co., of Cleveland, recently built an ore-transfer car for blast-furnace work weighing 100,000 lb. and having a carrying capacity of 100,000 lb. This car operates in shuttle service within the confines of the furnace property. It is driven by a six-cylinder 5½ x 7-in. engine that drives through a 150-hp. Hele-Shaw clutch and a transmission that was designed by two members of the Society, Gordon R. Pennington and S. K. Wellman, of Cleveland. At present the car is in the service of the Perry Iron Works at Erie, Pa., and is performing splendidly. This class of work generally has been done with electric transfer-cars but, because of the danger of a third-rail, the advantage of using a gasoline-propelled car is apparent. It looks as if that class of work might develop into rather a large field for automotive equipment.

The Pennsylvania Railroad has in service at two water-level terminals, Baltimore and Jersey City, a number of 15-ton gasoline-electric tractors that are used solely for switching purposes, that is, for "spotting" cars. These tractors are of the four-wheel-drive, four-wheel-steer type, are mounted on 56-in. rubber-tired wheels and have a tread that straddles the standard-gage track. With that type of running-gear they can be driven over the rails from one track to another to draw away a freight car. The railroad company is somewhat reticent about giving information about these tractors but I know that they are highly satisfactory and perhaps they offer another opportunity in the field of heavy automotive equipment.

The industrial locomotive used by contractors at quarries and mines and in large construction works, which formerly was a 3½ or 4-ton unit, is gradually increasing in size. Already some of them weigh 18 or 20 tons. This equipment operates on rails and is closely allied with the development of the gasoline rail-car for passenger and freight service. This is another problem that I feel that the Society would do well to recognize and give some study. Many of these locomotives are constructed with great precision and some of the manufacturers are building them according to the best automotive practice.

Mr. Guernsey mentioned the development of the small Diesel engine. The company with which I am associated has had in operation for 5 months a 300-hp. full-Diesel engine weighing a little less than 45 lb. per hp. in the six-cylinder size. It is of the two-cycle type and can be supplied in any number of cylinders, as each cylinder is a complete operating unit in itself. It is possible that, with the placing on the market of this engine, a smaller Diesel engine will be developed that may be applicable to the smaller sizes of rail-car and locomotive.

Employes Accustomed to Electrical Equipment

E. J. BRENNAN[7]:—The experience of the Chicago Great Western Railroad has been somewhat different from that which Mr. Guernsey has developed in his paper. Any of our engineers can qualify as operators of the rail-cars if they really try and it is not necessarily true that the oldest man in point of service can demand the job whether or not his ability entitles him to obtain and hold it. Our engineers have taken more readily to the gas-electric car than to the mechanically driven car, and we are inclined to disagree with the statement that the maintenance of electrical equipment is not generally so well understood as that of mechanical equipment. It has been our experience that the maintenance of the electrical equipment has been handled to much better advantage by our forces, because the men have been accustomed to the repair and maintenance of electric motors in our shops and powerhouses and on the locomotives. In fact, they are more accustomed to such work than to working on the transmission system of a mechanically driven car.

I offer the suggestion that in the list of advantages of the electric transmission reliability be placed first, as approximately 75 per cent of the failures that we have had with motorized equipment has been due to the clutch, gears and other transmission elements in the mechanically driven cars.

The development of two bevel-gears meshing with a common pinion is interesting to note. Our experience has been that it is somewhat difficult to maintain the bearings and keep the gears quiet even with an installation of one solid gear on the axle driven by a pinion.

Assuming that the clutch referred to is of the dry-plate type, our experience has been that the life of such a clutch has been rather short, and it will be of interest to observe the performance of the clutch in the test of service.

No comparison of the construction of the gasoline or the gas-electric car unit with the usual railroad passenger coach should be made, because the latter is designed, first, to withstand the severe buff, pull and heavy strains to which such cars are subjected in steam-railroad service. The rail-car body, in our opinion, should be constructed to accommodate an underframe that is well designed to be consistent with the service in which the unit is to be used, and the stresses should be subdivided between the underframe and the steel body of the car.

[6] M.S.A.E.—Commercial engineer, Climax Engineering Co., Cleveland.

[7] Superintendent of motive power, Chicago Great Western Railroad Co., Olewein, Iowa.

SOME RECENT WORK ON UNCONVENTIONAL TRANSMISSIONS

BY P. M. HELDT

ABSTRACT

IF automobile builders had available a variable transmission that was capable of giving any ratio between the upper and the lower limits and that substantially was equally satisfactory at all ratios from the viewpoint of efficiency of transmission, wear and quietness of operation, a comparatively large reduction-ratio would be used most of the time, because that would assure the greatest fuel-economy.

Several types of continuously variable gears have been used on automobiles, or merely suggested for such use. Of these, the systems employing belts and friction discs or wheels need hardly be considered at present, because of their bulkiness and comparatively low efficiency. Much work has been done on hydraulic transmissions, chiefly with a view to their use on trucks and other heavy types of vehicle, and to increase the average efficiency of transmission it has been suggested recently to combine a direct drive with the hydraulic gear, so that the loss due to the double conversion need be sustained only under conditions of rapid acceleration and heavy traction. The form of hydraulic gear referred to is automatically variable in accordance with the torque load.

Variable-throw-type transmissions have been invented in great numbers but, so far, little commercial success has been attained. The most advanced design seems to be the Lavaud, developed in France, which at present is being given an endurance test by the French automobile builder, Voisin. With this design, the torque reaction on the rear-axle housing changes the angularity of a swash-plate and thereby varies the ratio. The weakest element of a variable-throw transmission seems to be the ball or roller ratchet, which must be made comparatively large for the amount of power to be transmitted.

The Weiss transmission, which was demonstrated at the 1924 Semi-Annual Meeting, is in a class by itself; hence, a simple explanation of the principle involved is given. In England, Constantinesco has been working on a transmission combining the variable-throw and the inertia principles. In inertia-type transmissions, the energy supplied by the driving shaft is stored up in reciprocating or oscillating weights and is then given up to the driven shaft at the same rate at which it was absorbed but with the relation between torque and speed changed. Although it is possible theoretically to make use of the inertia principle alone, without having recourse to a variable-throw device, no practical mechanism of this type seems to have been evolved as yet.—[Printed in the July, 1925, issue of THE JOURNAL.]

THE DISCUSSION

CHARLES R. PRATT[8]:—An hydraulic transmission that has driven a 3-ton truck for the last 15 years, has outworn three gasoline engines and is still as good as new, has recently been further developed to overcome the several objections cited in Mr. Heldt's paper. Its latest model Type F-10 is 9½ x 9½ x 26½ in. in dimensions, has a 200-lb. total-weight and will deliver 40 hp. at 1800 r.p.m. It is of the axial-piston type, similar to the Waterbury; but, by radical differences in design, it removes the objections of excessive size, weight, cost and low efficiency on high gear, which exist in other types of hydraulic-piston transmission.

This Type-F hydraulic-transmission consists of a variable-stroke pump and a variable-stroke motor exactly alike, each having a cylinder barrel with seven pistons grouped like the cartridges in a revolver. The two cylinder-barrels face each other, with a port plate between having semi-annular ports through which half of the pump pistons are pumping a high-grade lubricating-oil to push against half of the motor pistons, and half of the motor pistons are pushing the same amount of oil through the other semi-annular port to the pump's pistons that are on their suction stroke. This makes a continuous flow of pressure oil through straight unrestricted ports, direct from the pump to the motor pistons, the fluid velocity at no point being greater than the piston velocity, instead of being forced through restricted ports at several times the piston velocity, as in all other types of hydraulic-piston transmission. Using a piston-rod sprocket torque-drive instead of universal-joints to drive the "swash-plate" discs at angles of 20 deg. reduces the pitch diameter of the circle of the seven pistons, thereby reducing their tangent velocity over the port plate and, by lower fluid-velocity and no "figure-8-error" of a universal-joint, attains a higher number of revolutions per minute and greater efficiency on high gear. The gasoline engine drives the pump's cylinder-barrel, and the pump's pistons pump oil against the motor's pistons that drive the propeller-shaft and the driving wheels.

The gear ratio is the number of revolutions that the pump must make to cause the hydraulic motor to revolve once. When both are at full stroke and the pump delivers and the motor receives an equal quantity of oil per revolution, then they will both revolve at the same speed and their gear will be on "high"; but when the pump is reduced to one-tenth stroke it must make 10 revolutions to make the hydraulic motor revolve once. The limit of gear ratio at maximum oil-pressure for maximum tractive-effort in hill climbing is the minimum percentage of leakage at maximum pressure; and, if it is less than 10 per cent then the pump will drive the hydraulic motor at a low gear-ratio of 10 to 1, which is maximum motorcoach or motor-truck ratio. But in starting a car, motorcoach or motor truck from zero pump-stroke, the gear ratio starts at infinite low, as the swash-plate leaves neutral to begin the increase in pump stroke. Also, in traffic, with the pump stroke at just beyond the leakage limit, the car will be driven at a speed too slow to be observed.

Hard-steel face-plates on each cylinder-barrel are held by roller thrust-bearings within a split thousandth of an inch from the hard-steel faces of the port plate, with labyrinth packing-rings to check leakage velocity, and with cast-iron pistons ground to a perfect fit in the bores of their cast-iron cylinder-barrels. The percentage of leakage at maximum oil-pressure permits maximum hydraulic gear-ratio, and an efficiency that keeps the pressure oil within working temperatures. Pressure oil leaking into the casing is held there at a pressure of 15 lb. per sq. in. above the pressure of the atmosphere, generated by oil vapor and limited by an air relief-valve. This helps the pump's suction stroke at high speeds. Leakage oil from the casing flows through a gravity separator-tank that returns it to the pump's suction

[8] M.S.A.E.—Engineering editor, Class Journal Co., New York City.
[9] Consulting engineer, Upper Montclair, N. J.

through check valves, cool, clean and free from air or water, and keeps down the temperature of the transmission. The high-grade lubricating-oil used for the pressure fluid is forced by leakage pressure into the center bore of the two main shafts and from there is fed under pressure and by centrifugal force to all bearings. Loss of this oil by leakage and deterioration is very slight, and so long as enough remains to drive the transmission, all bearings are assured of a flood of pressure lubrication.

Hydraulic Transmission Control and Operation

This transmission is controlled by two pedals geared together so that pushing down on either one raises the other pedal an equal distance, and a foot on each gives positive control of both pedals. The pedals replace the clutch, the gearshift and the service brake.

In neutral position the pump is at zero stroke and the hydraulic motor at full stroke, which leaves the gasoline engine free to crank but locks the driving wheels except for a slight creep when on a steep grade, which creep is stopped by the emergency brake if the vehicle is parked, or by giving the pump a slight stroke to hold the vehicle still in traffic.

To start forward push the left pedal, and to start to reverse push the right pedal. The first advance beyond neutral starts the pump's stroke and starts the vehicle at an infinitely low gear-ratio, which uses 100 per cent of the gasoline engine's torque instead of wasting 50 per cent of it in the slip of a friction clutch. Continued advance of the pedal brings the pump to full stroke and drives the vehicle on high gear.

To accelerate to full speed as quickly as possible, kick the left pedal to high-gear position where it will be held by a cam dwell-point when the feet are removed from both pedals. An automatic control then limits the advance of the pump's stroke to the maximum oil-pressure for which it is adjusted, whereby the load on the gasoline engine is limited to its maximum torque without slowing down below its efficient speed, and the torque on the driving wheels is limited to their maximum grip on the road without skidding. This accelerates from rest to full speed using all of the gasoline engine's maximum horsepower, with the maximum grip of the tires on the road without skidding and without the loss of any time in changing to high gear from the neutral position. As the load on the gasoline engine remains constant, a fixed position of the gasoline throttle at the steering wheel regulates the gasoline supply.

The foregoing operation should be compared with the present clutch and gearshift, for the operation of which the driver must

(1) Release the clutch
(2) Throw the gearshift lever to first
(3) Step on the gas
(4) Release the emergency brake
(5) Throw the clutch in
(6) Let the car drive a few feet
(7) Release the clutch
(8) Let up on the gas
(9) Throw the gearshift lever to second
(10) Step on the gas
(11) Throw the clutch in
(12) Let the car drive a few feet
(13) Release the clutch
(14) Let up on the gas
(15) Throw the gearshift lever to high
(16) Step on the gas
(17) Throw the clutch in

While an expert driver with clutch and gearshift in their best condition will make these 17 consecutive motions in a split second of time for each motion and accelerate to full speed without excess racing and slowing-down of the gasoline engine, jerking the car, the motorcoach or the motor truck or skidding the wheels, the average driver will lose as much time in making these 17 motions as it takes the hydraulic transmission to accelerate from rest to full speed and he will not use half of the gasoline engine's continuous horsepower, he will wear the gears, jerk the car and wear the tires by skidding.

It is evident that by one foolproof kick on one pedal of an hydraulic transmission, a car, a motorcoach or a motor truck accelerates perfectly from rest to full speed in less than half the time and distance that the average driver takes to accelerate the same motor-vehicle imperfectly with a clutch and gearshift that require 17 consecutive motions of both feet and one hand.

To stop in the shortest possible distance with this hydraulic transmission, bring the pedals instantly to neutral and a relief valve limits the oil pressure and the braking effect on the driving wheels up to the limit of their grip on the road without skidding, or, if four-wheel brakes are preferred, the oil pressure developed by deceleration can be piped to hydraulic brakes on the front wheels, whereby the front wheels are stopped by friction brakes at the same time and with the same braking effect as the driving wheels are stopped by the hydraulic-motor pistons. Further, on account of an assured supply of oil and an automatically regulated oil-pressure, this braking effect is more reliable and accurate than is possible with any kind of a manually operated hydraulic brake.

On hills too steep to climb on high gear, leave the pedals on high gear and the automatic control will keep the gear ratio exactly equal to the gasoline engine's maximum torque at its efficient speed. If held back by traffic, bring the pedals toward neutral and the vehicle will slow-down, stop and start-up as easily as if on a level road.

On a smooth straight road with no traffic hazards, and where any speed is safe, give the gasoline engine all the gasoline it will take and slowly advance the forward pedal beyond high gear until the gasoline engine begins to slow-down. This has left the pump at full stroke but has shortened the hydraulic-motor stroke so that each revolution of the pump drives the motor more than one revolution, the propeller-shaft is making a greater number of revolutions per minute than is the gasoline engine, and the car is making as many more miles per hour than on even high gear, say from 50 to 100 m.p.h. with no increase in gasoline-engine speed, because the gasoline engine has the horsepower needed to drive it.

Free coasting with the gasoline engine stopped saves gasoline and minimizes engine and tire wear; but, with the present gearshift, it is not safe or expedient to coast on 1 per cent of the short hills and slight grades, or while decelerating for traffic, curves and stops; but, with this hydraulic transmission the action is simply to

(1) Throttle the gasoline to the idling point
(2) Push the forward pedal as far as it will go beyond high gear; then the hydraulic motor goes to zero stroke while the pump remains at full stroke; this stops the gasoline engine and frees the driving wheels for coasting
(3) Bring the forward pedal back toward or to high-gear position, and the coasting car cranks the gasoline engine and starts it to driving again, or it slows the vehicle down by coasting under compression

(4) Bring the pedals to neutral and the driving wheels stop without skidding

With this easy simple action the average driver of a car, a motorcoach or a motor truck, will not miss a foot of coasting, will not lose a minute of trip time, will make a very material saving in gasoline and minimize engine and tire wear.

As to parking and turning around in small spaces, by oscillating the two pedals up and down a fraction of an inch per second the car, motorcoach or motor truck will oscillate back and forth a few inches per second and thus get into or out of a small parking pocket, or turn around in a narrow road easily and quickly.

These are conditions of motor-vehicle control that should be met and that the present gearshift cannot meet. Hydraulic transmission already has met these conditions but producers will not put it into quantity production until the public demands it. The public should demand and get hydraulic transmission.

DEVELOPMENT DIFFICULTIES AND THE DESIGN OF THE HYDRAULIC-BRAKE

BY H. E. MAYNARD[10]

ABSTRACT

THE principles of hydraulics have long been known and the use of a liquid for transmitting power has proved safe and reliable in many applications, notably in the operation of passenger elevators, hence it was natural to make use of these principles in a device for controlling an automobile under traffic conditions that demand an efficient and dependable braking mechanism. The ideal of equalized braking-effort is sought but variation in the coefficient of friction between brake-bands and brake-drums and between tires and road introduces complications, so we must be content for the present with the nearest possible approach to equalized pressure at the brake-bands. In the hydraulic system, pressure is transmitted equally throughout the liquid and to the levers that actuate the brake-bands. These levers are also designed to transmit the pressure equally to the brake-bands on all four wheels.

The author describes briefly the general construction of the system but dwells more particularly upon the development of the major elements and the difficulties overcome in the search for entirely satisfactory materials. A slip-joint connection between the brake-pedal lever and the piston in the master cylinder was adopted to avoid drawing air into the system and producing soft pedal-action due to compressibility of the air. For the same reason a positive hand-operated plunger-pump with a needle valve is used for refilling the master cylinder from the supply reservoir. It was necessary to develop a flexible hose connection from the rigid tubes on the frame to the wheel cylinders that would be non-collapsible and also non-expansible under internal pressure, and the solution of the problem is described.

Prolonged search for a material that would resist temperatures of more than 200 deg. fahr. and that would otherwise be suitable for use in the cups that provide the seal for the pistons in their cylinders finally resulted in the adoption of a special rubber composition. The liquid used in the system must remain fluid at temperatures well below zero, must not corrode the copper tubes or the cast-iron cylinders, must not attack the rubber cups and hose nor become gummy. That now used with satisfaction is a solution of 50 per cent castor oil and 50 per cent alcohol, neutralized with potassium hydroxide.

In a four-wheel-brake system, equalized pressure applied to all wheels is believed to give the maximum safe braking-effort. When the brakes are applied the center of gravity of the car's mass moves forward and often as much as 50 per cent of the weight is transferred to the front wheels, consequently equal braking-effort on the front and rear wheels assists in stopping all wheels at the same time, yet the likelihood of locking the front wheels is slight. In simultaneously making a turn and braking, with equalized pressure, the shifting of the center of gravity toward the front and toward the outside of the turn results in locking the inside rear-wheel first, then in succession the outside rear-wheel, the inside front-wheel and finally the outside front-wheel, thus automatically giving maximum braking-effort on the turn as well as on the straightaway.—[Printed in the September, 1925, issue of THE JOURNAL.]

THE DISCUSSION

F. E. MOSKOVICS[11]:—In addition to suggesting that we have metal-to-metal contact, I wish to call attention to the fact that the secret of the efficiency and durability of the bicycle coaster-brake lies in the fact that it has considerable variation in the coefficient of friction. Instead of using two soft metals, the shoes are made of the hardest metal and the shell of a somewhat softer one. When you think of a bicycle brake 2.0 in. in diameter and 0.3 in. wide, it begins to open your eyes. I do not think anyone ever saw one that was worn out. Some man here from the New Departure Mfg. Co. might tell us what the proportions of wear are in the coaster-brakes. I think there is more to it than appears on the surface.

Another thing, I should like to hear a little more about the mechanical factors of compensation, whether we have compensation or do not have it.

SANDFORD BROWN[12]:—I am not a brake-lining manufacturer, a brake manufacturer nor a car builder, but I have been trying to obtain some information about brakes and brake-linings. There seems to be absolutely no standard. The car builder, in general, does not seem to know exactly what he wants and the brake-lining manufacturer, on the other hand, apparently has no means of judging his lining in comparison with other makes. I have asked a number of lining manufacturers what the standards are and how they make their tests, and no uniformity seems to exist.

A car builder will send a test car out with a driver, who reports that the lining is too hard or too soft. That is a queer way of attempting to judge a thing when you want to set standards of efficiency to work to. I think if the car builder would tell the brake-lining manufacturer what he wants and the lining manufacturer would make known what he can produce, they would begin to get somewhere.

What is a brake-lining? Fabric linings, whether they are molded or woven, have asbestos as their base, and

[10] M.S.A.E.—Engineer in charge of design, Maxwell Motor Corporation, Detroit.

[11] M.S.A.E.—President and general manager, Stutz Motor Car Co., Indianapolis.

[12] M.S.A.E.—Director of engineering, Bakelite Corporation; president and general manager, Halowax Corporation, New York City.

they have cotton and some rubber, gilsonite, linseed oil and such things. The brake manufacturer says,

> We make what the car builder pays for. We can make a good four-ply lining with 12 or 15 per cent of cotton, but they will not pay the price for it, so we put in 20 or 25 per cent of cotton, and use short staple cotton at that.

I think the car builder must set up some standard. What is it that makes a brake-lining swell? It is the bleeding-out of the impregnating material, the gilsonite or linseed oil or something like that, which has not been properly oxidized. When it is heated it is driven out. The same is true of rubber; if it becomes hot enough, it will lose its properties, but if it is not heated we have a fairly stable condition. Humidity and barometric pressure cannot be stabilized, but if we have some standards to aim at, we can begin to improve some of the characteristics of the lining.

CHAIRMAN W. R. STRICKLAND[13]:—I do not think cooperation has been lacking; the fabric manufacturers have worked with a number of car builders in producing special linings.

C. L. SHEPPY[14]:—My company has conducted extensive tests on different kinds of lining. To begin with, the life of the lining will depend, of course, on the pressure, the amount of lining to perform a given amount of work, and on the heat dissipation. It is a fact that a lining is made today that gives about three times the mileage and costs about three times as much as ordinary lining. It is about three times as hard, and that means that it is necessary to put on a high-carbon drum, or the ordinary stamped drum must be carbonized and ground. The public should be willing to pay that additional cost if it wants safety. Then I think the brake-lining people will give the car builder what he and the public want.

CHAIRMAN STRICKLAND:—Can we have some information in regard to the increased use of the brake when four-wheel brakes are applied? Is there any answer to Mr. Moskovics on compensation?

A. Y. DODGE[15]:—I have been experimenting with brakes for 4 years and in that time never have found two that were exactly alike. If someone will devise a perfect brake compensator to compensate the actuating force, put it on a car and put four brakes on the car, and each of those four brakes is a little different from each of the others, what has he gained? He has equalized the force to those brakes but that may not be what he wants to do.

On some occasions two wrongs do make a right. I do not want to admit that the absence of compensators is wrong, but I do say that if, in production, you find a brake that is a little more effective than the other three brakes on a car, you can easily make those brakes equalize when no compensators are used, but when compensators are used all the brakes must be more nearly alike.

Because of the adjustability of the Bendix brake at the anchors and because of the concentric brake-design, we have brakes that are more nearly uniform than any others I have investigated, but they are not absolutely the same, neither is the brake-lining always the same although it may come from the same roll. Mr. Burkhardt pointed out very aptly in his paper the different pressures on a brakeshoe, depending on where the shoe gets heavy contact with the drum. We can make brakes perform equally by giving them different actuating forces and cause them to wear equally in doing so.

CHAIRMAN STRICKLAND:—We have had two papers presented to the Society on the subject of equalizing brakes at the anchor, one mechanically and one hydraulically. Are there any representatives of those brake designs present?

OTTO C. LANG[16]:—I do not quite agree with Mr. Dodge about two wrongs making one right. If we eliminate the error between the actuating means to the bands, we do accomplish something.

MR. MOSKOVICS:—I never have driven a car with no equalizing points that did not have a tendency to run to one side in steering under certain conditions, and I have driven perfectly equalized four-wheel-brake cars without feeling that tendency. Of course, the tendency is exaggerated in driving on crowned roads and getting the pull to one side, but that is the condition under which we are driving and I cannot altogether see the force of Mr. Dodge's philosophy, which is very dangerous. If two wrongs do make a right sometimes, 10 wrongs ought to be just five times as good, so we should introduce more wrongs and improve the conditions.

MR. BROWN:—I might suggest that the car builder try to set-up three standards for the lining manufacturer to try to meet, or else the lining manufacturer could set them up so that the car builder would know what kind of lining he will get. Three things, among others, in a lining affect the braking characteristics. One is the wear. Take standard 2-in. lining and specify that it shall not wear more than so many thousandths of an inch in so many revolutions of a given size of drum, which is equivalent to so many car miles. There you have one standard.

Another factor is the variation due to temperature of a lining. If you could say that up to a temperature of 350 or 400 deg. fahr. the lining should not swell more than so many thousandths of an inch, there is another standard.

The third factor is the moisture content. Everybody seems to say that it is an accepted fact that no such thing as a textile lining that is constant under all weather conditions exists. The car builder says, "This lining is pretty good and this one is not so good under wet-weather conditions." He cannot tell what the moisture absorption of that lining is. Suppose you take standard pieces of lining of so many square inches and give them 24 hr. submersion, check that and set the best one up as a standard.

CHAIRMAN STRICKLAND:—The requirements for braking are increasing every day. The campaign for safety that we all favor demands good brakes. The four-wheel brake undoubtedly has been a big step in the right direction, making cars from 25 to 50 per cent safer. Naturally, wear of the lining has increased in proportion to the greater need for braking. You cannot stop the car mass in less distance with brakes without using up material, grinding it off, even though you use cast iron. How is the tire mileage affected on the two-wheel brake as against the four-wheel brake? We used to skid the wheels with the two-wheel brake; the brakes did not wear but the tires did.

MR. SHEPPY:—Tests were made by our company in which two-wheel brakes were compared with four-wheel brakes on cars of the same weight. Those tests were very extended and covered all of the mountainous and hilly country we could reach. I believe it is safe to say that the average life of the two-wheel brake was between 8000 and 12,000 miles without adjustment, possibly a

[13] M.S.A.E.—Assistant chief engineer, Cadillac Motor Car Co., Detroit.
[14] M.S.A.E.—Chief engineer, Pierce-Arrow Motor Car Co., Buffalo.
[15] M.S.A.E.—Chief engineer, Perrot Brake Corporation, South Bend, Ind.
[16] A.S.A.E.—Sales manager, Hydraulic Brake Co., Detroit.

little less, but that of the four-wheel brake was about four times as much. Tire wear was considerably less with the four-wheel brake than with the two-wheel brake. The four-wheel brakes should have greater life, because they have a greater area of braking surface per unit weight of car. The only other variable that might enter is that possibly we drive a little faster than we used to.

CHAIRMAN STRICKLAND:—Mr. Moskovics brought up the subject of coaster-brakes and inquired why the same principle would not be applicable to passenger cars or other automotive equipment. Can Mr. Hughes tell us something as to his experience with coaster-brakes and what the possibilities might be today?

F. G. HUGHES[17]:—The bicycle coaster-brake for many years, as you all know, had metal-to-metal contact. Various types of braking surface have been provided, of which two remaining types are now extant, one that uses a bronze shoe with a large area and another having a spring-steel brakeshoe divided into three sections running against a carbonized brake-drum. The latter type is the one that our company has made since 1903, and we find that the carbonized brake-drum of fairly large diameter for a coaster-brake, that is, about 2½ in., with a shoe that is about 0.4 in. wide, divided into three sections of spring, gives longer life than the bronze shoe of larger area, possibly because of the difference in metal.

Some difficulties, of course, are encountered in applying that type of brake to the automobile. In the hilly districts where there are long hills the tendency is to draw the temper of the drum. Possibly that could be taken care of in the automobile by some cooling arrangement.

Looking at the brake problem from the combined experience of the coaster-brake men and the automobile men, I think a metallic brakeshoe in some form of hardened drum would have a great future. I should not say that the spring-steel type of shoe, from our experience with the bicycle coaster-brake, on which the loads are comparatively very light, would be at all advantageous in the automobile. Possibly some form of cast-iron shoe might be worked out; I think it has been in some instances.

MR. MOSKOVICS:—I think this is, in a way, the most important session the Society has had. It seems to me that we have an opportunity to get real brakes; better brakes may cost a little more, but when it comes down to cost, if the killing annually of as many people as were killed in the war is a factor, should cost be considered? Let us have good brakes and do all we can to make the automobile safe for democracy.

CHAIRMAN STRICKLAND:—I would like to ask Mr. Hughes about the brake practice on motorcycles. I can see that on a bicycle a 200-lb. man climbs only a small hill and does not have occasion to use the brake on a very long steep descent.

MR. HUGHES:—I have not been very familiar with the motorcycle brake in recent years, but at the time we ceased its manufacture, the tendency was toward a metallic shoe with a friction lining. For many years since Mr. Moskovics's connection with our company we were experimenting with a disc type of bicycle brake that has worked out exceedingly well. Practically our entire export business is of this type. It is a disc clutch, if you wish to call it that, with a steel disc and a bronze disc facing each other. This has worked out even better than the hardened-steel shoe on the larger drum. We use a much smaller diameter and oil cooling and oil lubrication.

CHAIRMAN STRICKLAND:—In justice to the fabric-lining manufacturers, I want to say that my company considers safety on the front brakes of utmost importance. We studied the lining question from every standpoint and finally wrote specifications and developed them to answer the question to the best of our ability. We were looking for a lining that would absorb as little moisture or oil as possible, so that the recovery in operation would be quick. That meant putting more of the impregnating material into the lining. The lining should be of such a nature that the application of heat would not spoil it; it requires very careful heat-treatment. In our case the lining is heat-treated three times to bring it almost up to the limit of endurance of the fabric under heat.

Another condition that we believed we needed was that the coefficient of friction on the front-wheel brakes should never increase but would either remain the same or decrease if the lining was heated or cold.

The lining problem has been worked on and I believe that the fabric manufacturers are in good position today to supply the car builders with what they want as soon as the builders know what they want, and many car builders do know.

AUTOMOBILE-NOISE MEASUREMENT

BY H. CLYDE SNOOK[18]

ABSTRACT

AUTOMOBILE noise, although useful as a detector of mechanical imperfections of car operation, is otherwise so extremely undesirable that elaborate methods for analysis with a view toward preventing or suppressing such noise are warranted since it is, according to the author, sound disagreeably out of place. He therefore presents an illustrated and detailed description of the mechanism of human hearing, according to studies made in the interests of telephonic transmission of maximum effectiveness, enumerating and explaining the devices developed for evaluating the sources of sound and its modes of propagation and amplification, because the noise problem as it concerns the automotive engineer must be considered not only as a problem in physics but also as a problem in the physiology of hearing.

An automobile can be considered to be composed of a number of acoustic resonators having varied degrees of coupling between them, and comparisons are made of the velocity of sound propagation through the different materials with that of its transmission in air, the velocity being greater in the structural material. The apparatus used for the detection of noise and its measurement consists of varied types of equipment, divided into two classes; one includes the contact type and the other the air-impact type, both being exemplified and discussed.

Following an enumeration of the different detectors and auxiliary apparatus in use and comments upon the methods employed, it is stated among other conclusions that it seems advisable to base loudness measurements of automobile noise upon the difference of energy between the measured sound and an arbitrary standard of sound which is the threshold of normal hearing; that, to locate the origin of automobile noise, it frequently is sufficient merely to detect the noise without measuring its loudness; and that, to identify

[17] M.S.A.E.—Vice-president, New Departure Mfg. Co., Bristol, Conn.

[18] Bell Telephone Laboratories, Inc., New York City.

the origin of automobile noise, it often is of value to ascertain its component frequencies. [Printed in the July, 1925, issue of THE JOURNAL.]

THE DISCUSSION

T. V. BUCKWALTER[19]:—In my experience in engineering I have learned that an engineer frequently finds himself in that No Man's Land which lies between the production department and the sales department and where he must keep everybody happy. He must approve a product that the production department can make with facility and rapidity, and at the same time his product must be acceptable to the consumer.

In the supplying of component parts, such as bearings, to the automobile industry, we have had much difficulty in the past in providing bearings that were satisfactory from the noise standpoint. One of the reasons for this was that we did not know what kind of noise would be acceptable to the users of bearings. Mr. Snook has given a good explanation of the masking of sounds. We have observed for a number of years that a bearing that had a sound-pitch that was likely to be in symphonism with the mechanism on which it was mounted could be termed noisy even though it would be entirely satisfactory in other classes of service in which the mechanism had a different frequency. We have had to study the transmission and the pinion very carefully to be sure that the noise set-up by these mechanisms would mask the noises produced by the bearings. If, as unfortunately would be the case at times, we should have a bearing that was of about the same sound-pitch as the transmission, so that its noise would not be masked by the gear noise, we would have a noisy bearing.

Other things have affected this situation sometimes in unlooked-for quarters, as, for instance, the noise set up by the sculpturing on certain kinds of tires, which at times synchronizes with, and reveals, the gear noise and the bearing noise.

This noise question would arise with great irregularity and no one could foretell from what source the complaint was likely to come. The production department would work days and nights on the problem, while the sales department would endeavor to sell what we could make. After awhile the trouble would be corrected, bearings would be salable again, and we would not know how the trouble had been overcome. Production and sales would go along for another period and then we would have another epidemic of noise. This condition led the management of our company to study the noise problem from a scientific standpoint and, recognizing that as bearing manufacturers we were not equipped to solve it, the management delegated the University of Michigan to study the problem and endeavor to develop a machine with which we could test bearings and determine in advance whether or not they would be satisfactory for the purpose for which they were intended. The machine that was developed as a result of the study was described by F. A. Firestone[20], who, with the assistance of his chiefs, was instrumental in its development. It was demonstrated by him at the 1925 Annual Meeting of the Society in Detroit, and it has been very successful. It has enabled us to use the electrical noise-filter so effectively that we could filter-out all extraneous noises that might be due to inaccuracies of slow-moving parts, as, for example, the inner ball-race, and concentrate on the betterment of those parts, such as rolls, that have a likelihood of coming into symphonism with the gearing. Gearing is our big bugbear. If we can avoid the gearing troubles and make the pitch of the bearing noises that we cannot eliminate of such frequency that they will be masked by the noise of the gears, everything is satisfactory.

There is a limit to the accuracy with which any part furnished by the automobile industry can be supplied commercially. As gears are being improved, we must make bearings better. That means to make them more nearly accurate geometrically. A limit will be reached sometime. The Johannsen gage, which may be accurate to 0.00001 in., costs about $15 for a little piece of metal about the size of the end of one's little finger. I should like to supply bearings on that basis. We have to supply them at a very small fraction of that cost, but the indications are that, with automobile mechanism standardized as it is today and improved from the noise standpoint, an accuracy in the rolling elements of about 0.0002 to 0.0003 in. is sufficient so that the noises set-up by bearings will be masked satisfactorily by the noises caused by the rest of the automotive mechanism.

The noise-measuring machine that has been developed consists primarily of a radio apparatus and microphone devices. It is sufficiently simple for bearings to be passed through it at a rapid rate. A bearing is inserted in the machine and speeded up in about ½ sec. to 1200 or 1800 r.p.m., the rate depending upon the requirements of the customer and the purpose for which the bearing is intended. Within from ½ to 1 sec., the grease film that has been applied to the bearing to prevent oxidation is squeezed out, so that the bearing gives out a metallic hum. The dial on which the noise is indicated is set normally at about 25. It could be set at any other figure but 25 has been taken as an easy figure to work with. That dial position indicates absolute quietness in the noise booth and, as noises develop, a needle swings toward the center. Zero is the passing-point for the bearings. Any bearing that registers below zero, causing the needle to swing to the left to about 25, is rejected. Any that registers between 0 and 25 to the right is a passable bearing. Between 90 and 95 per cent of the bearings generally register a position about midway between the passing-point and absolute quietness, which is represented by the machine running without any test bearing in it.

The radio mechanism is contained in a box that can be set wherever the dial can be read easily. The microphone is set into a machine which is built on the order of a vertical drilling-machine and into which the bearings are inserted, and the microphone receives directly the vibrations that are communicated through the instrument to the dial. It has been a very satisfactory device and has been used now for more than a year. About 50,000 bearings per day are inspected regularly on this machine and passed or rejected on their dial reading. We are now in position, thanks to this machine, to ascertain the causes of any noise epidemics that may develop in any ordinary service in a very short time and to concentrate attention where any noisiness requires it, to correct the trouble quickly and to know what we have done when it has been overcome. Before we had the machine we floundered about and finally overcame the noise troubles but without knowing how it had been done and how to provide against similar trouble in the future.

CHAIRMAN J. H. HUNT[21]:—Our President stated that 5 years ago the subject of crankcase oil-dilution was

[19] M.S.A.E.—Chief engineer, Timken Roller Bearing Co., Canton, Ohio.

[20] See THE JOURNAL, February, 1925, p. 121.

[21] M.S.A.E.—Head of electrical division, General Motors Research Corporation, Dayton, Ohio.

mentioned officially before a Society meeting. It had been given consideration 10 years before that, and we are only now getting to the point where we are talking as though we meant to do something about it. This noise problem is another of these 10-year jobs, I believe. We are only starting on it and it will be some time before we work it out. The solution will be difficult because, instead of trying to put a talking-point into a machine, we are trying to eliminate something and then talk about its absence.

One very definite idea that we all can apply has come out of this paper. It is highly interesting and significant to note the variations in the hearing ability of different individuals, as shown on the charts, and the suggestion made by Mr. Snook that we should use calibrated ears for inspection work is an exceedingly valuable one.

Anyone who has ever been through some of these noise epidemics that Mr. Buckwalter mentioned remembers, I think, that the cycle goes somewhat like this: The trouble usually starts with a slight falling-off in the demand for cars, then follows an accumulation of the product in the car builder's plant that it would not be entirely convenient to pay for. Either the inspector is called to account or the inspector who had the pass ear when the plant was in a hurry for a product is replaced by an inspector who has a pass ear when the plant does not want the product. The trouble is now transferred to the plant of the manufacturer of the part or accessory said to be noisy, and the inspector there who has been passing the parts, and whose judgment may or may not have changed, is replaced by a number of men whose ears are more acute. A dispute follows among the inspection, the manufacturing and the engineering departments that usually lasts until sales pick-up again. After it is all over, as Mr. Buckwalter said, we do not always know just what was done to correct the fault, but if we use calibrated ears we shall know much better where we stand. I feel that we owe a debt of gratitude to the men who arranged for this meeting and to Mr. Snook and the Bell Telephone Laboratories, that have contributed so generously to it.

NOVEMBER COUNCIL MEETING

A MEETING of the Council was held in Philadelphia on Nov. 12, those present being President Horning, Past-President Crane, Vice-President Scott, Councilor Brumbaugh and Treasurer Whittelsey. Forty applications for membership were approved. The resignations of 13 members were accepted, and 5 members were dropped for non-payment of dues that accrued Oct. 1, 1924. Ten reinstatements to membership were made; also one transfer in grade of membership.

The financial statement as of Sept. 30 showed a net balance of assets over liabilities of $161,358.69, this being $1,161.46 less than the corresponding figure on the same day of 1924.

The net revenue of the Society for the fiscal year ended Sept. 30 last was approximately $216,000, the operating expense during the same period being a few hundred dollars in excess of this amount. This was considered an excellent showing in view of the fact that the budget for the year authorized a deficit of $11,500. The books of account are now being audited by public accountants. Final figures for the year in audited form will be submitted at the Annual Meeting of the Society.

The Council directed that, as stated elsewhere in this issue of THE JOURNAL, future issues of the S.A.E. HANDBOOK of Standards and Recommended Practices shall be in bound form and include advertising pages to defray necessary increased cost of furnishing the members uptodate complete Handbooks twice each year. The Council had before it various expressions of opinion on the subject, including tabulated figures of replies received from about one-third of the members of the Society. The members had been requested to express their individual opinion whether the HANDBOOK should be (*a*) issued as a bound volume; or (*b*) continued in loose-leaf form.

The number of affirmative replies to (*a*) received was 955; and to (*b*) 564. The remaining members who returned replies stated that they had no personal preference between (*a*) and (*b*). Nineteen members who voted for (*b*) gave specific reasons for doing so. The reason given by 12 of these 19 was the added expense involved in (*a*). The authorizing of including advertising in the Handbook counterbalances this expense and in addition will provide the members with information in a very convenient form as to sources of supply of products fabricated according to or incorporating Standard and Recommended Practices established by the Society.

W. M. Phillips was named to succeed B. M. Smarr as the representative of the Society on the Sectional Committee on Specifications for Zinc Coating of Iron and Steel. This Committee is proceeding under the sponsorship of the American Society for Testing Materials.

In connection with Sections activities, it was reported that on Nov. 5 of this year 2104 members had paid Society dues and 1513 had paid Section dues. The corresponding figures for the same day of 1924 were 1881 and 1078 respectively.

In the period from Jan. 1 to Nov. 7, 1925, 804 applications for membership were received, as compared with 633 received during the same months of 1924, and 532 in 1923. On Nov. 7, 1925, 5277 members were on the rolls of the Society, including Affiliate Member representatives, as compared with 5159 on Oct. 31, 1924, and 5125 on the same day of 1923. From Jan. 1 to Nov. 7, 1925, 577 applicants elected qualified as members, including those acting as Affiliate Member representatives.

GOVERNMENT PURCHASING POLICY

ALTHOUGH the Federal government has no centralized purchasing agency, it does have a centralized purchasing policy, as developed under the Bureau of the Budget and the Chief Coordinator. Purchases made for services located in the City of Washington are governed by the General Supply Committee. The list of articles for purchase include 15,000 items. The total purchases for the Government amount to over $250,000,000 per year. The largest item is food; the second, textiles; and the next, metals.

Mainly at the initiation of the Association of State Purchasing Agents, and later with the cooperation of a number of national organizations interested in purchases, the Secretary of Commerce instituted at the Bureau of Standards, under the general oversight of this group, the listing and assembling of all specifications in existence in this Country. These number over 27,000, some of them being greatly limited in their use by reason of the character of the material which they cover.

Six-Wheel Motorcoach Operation

By W. F. Evans[1]

Automotive Transportation Meeting Paper *Illustrated with* Drawings

ABSTRACT

THE six-wheel principle of chassis suspension represents a distinct advance in the art of construction of heavy-duty vehicles and has a tremendous future before it both for passenger and heavy-freight transportation, in the belief of officials of the Detroit Motorbus Co. after 1 year's operation of a fleet of six-wheel double-deck motorcoaches.

The company began operating dual-solid-tire double-deck motorcoaches 5½ years ago and after 2 years of operation arrived at the conviction that easier-riding vehicles must be provided to meet the desires of the public, to avoid damage to pavements and to decrease maintenance costs by reducing the vibration of the vehicles. Careful study of the progress made in the application of pneumatic tires to dual wheels on heavy-duty vehicles led to the conviction that their use on the double-deck motorcoaches was impractical. Attention was then diverted to developments in multi-wheel chassis, and the principle of weight distribution on more wheels, as in railroad practice, appealed to the officials as logical and as offering distinct advantages for motorcoaches. After serious investigation, an initial fleet of 37 six-wheel double-deck motorcoaches was placed in service in October and November, 1924. The total weight of one of these, with its crew and load of 60 passengers, is 22,000 lb. The vehicles were loaded at random several times, with a loadometer under each wheel, and the variation per wheel did not exceed 10 lb.

All of the advantages that were expected were realized fully in operation and many other advantages were gained. During the winter, when the streets of Detroit were glazed with ice for several days after a sleet storm, the motorcoaches showed no tendency to skid and always drew away from the curb without any spinning of the wheels. The motorcoaches have approximately 1 sq. in. of service-brake area for 17 lb. of vehicle weight as compared with 1 sq. in. to 34 lb. of weight in the dual-tire four-wheel motorcoaches. This large braking surface is to be increased nearly 50 per cent by the development of a propeller-shaft emergency brake. Because of the slight spring deflection under load, the floor of the motorcoaches rides practically level under all conditions of load, from empty to full. No spring breakages have occurred. The wheel-housing obstruction inside the vehicles is much less than in the dual-tire motorcoaches and it is planned to reduce this still more by widening the tread and using a heavy housing made integral with the chassis.

Lower maintenance and liability costs are outstanding results of the experience in operation of the vehicles. The only body work that has been necessary is renovating and repainting. Accidents have been greatly reduced because of the evenly balanced load and the non-skid characteristic of the chassis. Better running schedules have been maintained in all-season operation because of the more efficient traction and the better control of the vehicles.

THE Detroit Motorbus Co. has been operating a considerable fleet of six-wheel motorcoaches for a period of 12 or 13 months, and our experience leads us to believe that the six-wheel type of construction has before it a tremendous future, not only for passenger transportation but for the heavier truck loads, as it makes possible the handling of these heavy loads at higher speed, less abuse of the vehicle and greater protection to the roads. The company feels proud of the part it has taken in proving the six-wheel principle, because we feel sincerely that it represents a distinct advance in the art of construction of heavy-duty vehicles.

When the company started operation about 5½ years ago, it purchased the best equipment for the purpose that the market afforded at that time. This equipment, of course, had dual solid tires. After about 2 years of operation, we realized that we should be compelled to change to pneumatic tires on our vehicles within a short time, because the public was educated to a softer ride, and every evidence of a growing tendency upon the part of the public in our district to react against a solid-tire vehicle was seen. Detroit is an automobile-using city and knows the high standards for comfort established in that field; naturally, our company was among the first to sense this attitude. In addition to this, we desired to put ourselves beyond criticism in the matter of damage to the pavements. It also seemed necessary to reduce maintenance costs by decreasing the vibration transmitted throughout the entire vehicle from road-shocks when solid tires were used.

Objections to Dual Pneumatic Tires

Considerable study was given to the problem with a view to using pneumatic tires on the equipment that the company was operating, and a careful investigation was made of the progress that had been made in the application and use of pneumatic tires on vehicles in this type of service. To use pneumatic tires on the dual-wheel vehicle seemed impractical because of our inability to apply a tire of sufficient capacity to carry the loads without its taking up too much space in the body and raising the vehicle to such a height that it would not clear the viaducts in the city. Other reasons were awkwardness in servicing the inner tire, unequal distribution of load and work placed upon the tires when mounted in dual form, and excesive loads on the wheel bearings due to overhang. All things considered, the dual construction for pneumatic tires did not impress us as the logical way out.

Six-Wheel Principle Regarded as Logical

About this time our attention was called to developments in the multiple-wheel type of chassis, and it seemed reasonable that the methods employed by railroad engineers in reducing the wheel pressures, thereby protecting the rails and the roadbed and at the same time giving longer life to the cars and easier riding-qualities, were just as applicable to, and would afford at least equal advantages to, the trackless vehicle as were gained in operation of the rail type of vehicle.

This brought about a serious investigation of the progress in the development of the six-wheel type of chassis, and we were prompted to put some of these

[1] President Detroit Motorbus Co., Detroit.

chassis into operation on our double-deck type of vehicle, because the construction seemed to offer a solution of the major problems before us and appeared to be a progressive step. In taking up the six-wheel construction, we were particularly interested in the suspension of the load and its better distribution on the wheels rather than in any other details of the chassis design.

The first fleet of 37 vehicles was put into operation during October and early November, 1924. All of the advantages that we anticipated, as previously mentioned, have been realized fully in our operation, we believe, and many additional advantages from the operator's standpoint have been gained.

The total weight of the double-deck motorcoach is 22,000 lb., with its 60-passenger load and its crew. These vehicles were loaded at random several times, with a loadometer under each wheel, and the greatest variation in load per wheel that was observed did not exceed 10 lb. This was very gratifying to us and to the tire manufacturer as well.

In the winter of 1924 and 1925 an excellent opportunity to observe the non-skid characteristic and the tractive ability of this type of construction was afforded us. It will be recalled that during this winter there was a severe sleet storm which was rather general in a wide belt from the Mississippi River eastward. The streets in Detroit were glazed with ice for several days and the condition threatened to cripple our service. The six-wheel equipment showed no tendency to skid, however, and always drew away from the curb without any spinning of the driving wheels. These facts gave the passengers a feeling of much greater security, and they did not hesitate to show their preference for riding in the six-wheel coaches.

More Brake Area—Less Spring Deflection

The six-wheel principle also gave us an important advantage, from the standpoint of safety and lowered maintenance, in the tremendous braking area that this construction affords. On the six-wheel motorcoaches approximately 1 sq. in. of service-brake area is provided for each 17 lb. of vehicle weight. The nearest approach to this on any of our dual-wheel equipment is 34 lb. of vehicle per square inch of service-brake area. By way of future development we expect to use a propeller-shaft brake for emergency stops and thereby increase the brake area by about 50 per cent, which will, of course, add further to the life of the brake-linings.

The method of spring-suspension of the dual-wheel vehicle is well known. It makes necessary the raising of the rear-end of the vehicle considerably higher than the front end to protect the tires against rubbing in the wheel housings under the normal deflection of the springs under load. Because we could have less spring-deflection on the six-wheel vehicles and still obtain even better riding-qualities than in the four-wheel motorcoaches, we were able to avoid this difficulty and unsightliness and have the vehicles ride practically level under all conditions of load, from empty to full. It is worthy of note that, in all of the mileage we have made with the six-wheel vehicles, we have not had any spring breakage. Four springs have been removed because of improper treatment in manufacture, with consequent tendency to sag. Aside from this, no trouble whatever has been experienced, which is remarkable in comparison with our spring experience with dual-wheel vehicles on solid tires.

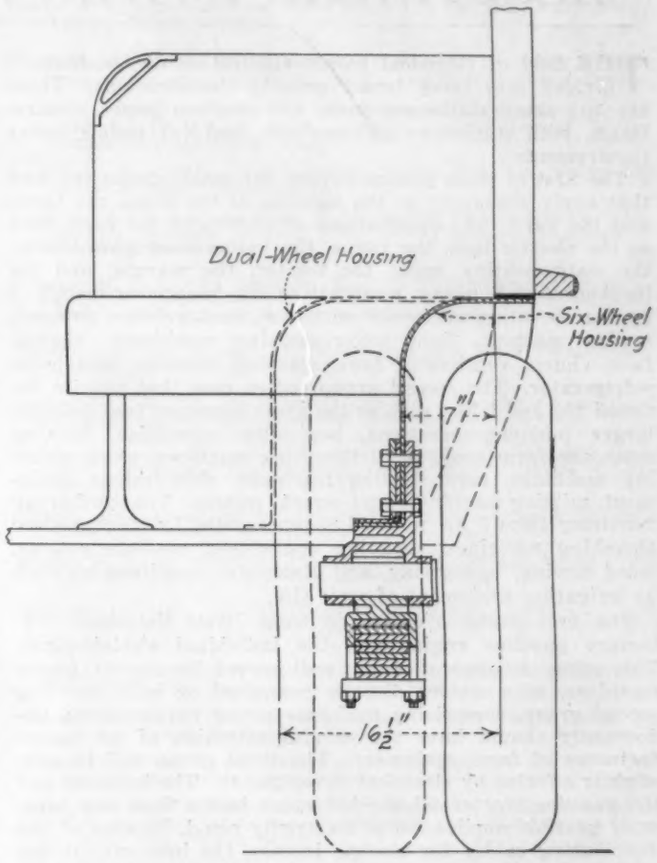


Fig. 1—Comparative Obstruction of Wheel Housings on Dual-Wheel and Six-Wheel Motorcoaches

By Widening the Tread and Forming a Housing of Heavy Material Made Integral with the Chassis Frame, as Shown in Cross-Section, the Obstruction within the Body Will Be Greatly Reduced and the Frame Will Be Reinforced. Note the Small Clearance of the Housing above the Tire, Made Possible by the Slight Spring Deflection in the Six-Wheel Construction

Lower Maintenance and Liability Costs

The outstanding experience that we have had in the operation of this type of chassis is, first, *lower maintenance cost*. This is the first fleet of vehicles that the company has operated for more than a year on which the only body work that was necessary was renovating and repainting, a fact that proves that the chassis design affords protection to the vehicle, which, of course, directly reflects the greater comfort of the passengers.

The next most important fact developed is the *lower liability cost* in the operation of these vehicles, due to the evenly balanced load and the non-skid characteristic. Further, in an all-season operation, we are able to maintain better schedules because of the more efficient traction and the better control of the vehicle.

It is planned to reduce the wheel-housing obstruction further by widening the tread and using a housing of heavy material that will be made integral with the chassis frame. Fig. 1 shows the comparative obstruction of the wheel housings on the dual-wheel chassis and the proposed six-wheel construction.

ELECTRICAL POWER AND FARM EQUIPMENT[1]

THE field of electrical power application on the farm is divided into three broad general classifications. These are (*a*) small stationary uses; (*b*) medium power requirements, both stationary and portable, and (*c*) mobile motor requirements.

The first of these groups covers (*a*) small stationary uses that apply electricity to the lighting of the home, the barns and the yard; (*b*) applications of electricity for heat, such as the electric iron, the range, the independent glow-heater, the water-heating units, the toaster, the mangle, and the incubator; (*c*) power applications up to approximately 2 hp. for operating the cream separator, meat grinder, sweeper, sewing machine, light water-pumping machinery, electric fans, churn, ventilating fans, washing machine, and home refrigerator. The second group covers uses that require between 2½ and 5 hp., such as the grain elevator, feed grinder, larger pumping-operations, beet-cutter operation, fanning mills, the farm shop, small threshing machines, grain cleaning machines, corn shelling machines, dehydrating equipment, milking machinery and cement mixers. The third group requiring from 5 hp. upward is represented by medium-sized threshing machines, spraying operations, ensilage cutting, wood sawing, baling hay, and stationary requirements such as irrigating equipment of some size.

The first group overlaps in some items the small stationary gasoline engine and the individual electric-plant. This group is unquestionably well served by electric power machines, with motors directly connected or built in. The second group, comprising moderate power requirements, undoubtedly should have the careful attention of all manufacturers of farm equipment. The third group will be only slightly affected by electrical development. The kerosene and the gasoline tractor fill the bill much better than any presently possible application of electricity could, because of the distributing cables for electric motors, the intermittent use of their power and its magnitude during their short periods of use.

Possibilities of Standardization

Referring again to the second group, we may anticipate here a considerable series of problems of standardization which must be solved to coordinate electrical and farm equipment products. The following points are suggested in this classification:

(1) A standard series of graded power-units and requirements must be established, with the minimum series of common powers—for example, ½, 1½, 2, 3, 5, 7½, 10, 15 and 25 hp.—so that there will be unity between the motors and the operated machines

(2) Uniform or standard belt-speeds should be set, such as 2000 ft. per min. and possibly 2600, 3000 and 3500. This would give us a common basis for determining pulley and gear sizes

(3) Standard mountings of motors will be needed to permit the use of various makes of motor on a given machine

(4) Standard heights of shaft centers will be needed to facilitate design

(5) Standard pulley sizes must be agreed upon, with established widths, gear sizes and face widths

(6) Standard safety regulations must be set up to comply with insurance requirements

(7) Standard methods of rating must be agreed upon as to both motors and operated machines

Some of the above questions of standardization are having careful consideration at the present time and this list will be extended as our study enables us more completely to understand the several problems.

Problems of the Farm Equipment Manufacturer

One of the important features for the farm equipment manufacturer to bear in mind is that wherever electric motive power is advisable, the economic rule applies that the desideratum is *the minimum amount of power spread over the maximum of time*. This is economy from the standpoint of the user because of lower investment in total equipment, and from the standpoint of the supplier because the load factor is better for the station. A new series of smaller sizes of farm machinery would thus be indicated, such machines being operated over longer periods. Examples of such possible operations are feed grinding, grain elevating, pumping, farm shop-work, small threshing machines, and corn shelling. Here is indicated the desirability of grouping machines and facilities so as to operate on lineshafts, and this consideration may further affect the entire arrangement of farm buildings to secure the fullest of electrical energy.

We have only started on a complicated problem, which must pass through the stages of adapting present equipment as well as possible, and of developing desirable coordinate optimum equipment as fast as stability factors show themselves. We still are far from being able to determine the extent to which this movement will be sensible but present indications are that the uses where more than 5 hp. will be called for will be few.

Electrical Problems Involved

The convenience of the electric motor drive in many cases, with its minimum of attendance as compared with the small gasoline engines, is counterbalanced by relatively higher operating costs. Line loss of from 30 to 50 per cent of the station input is one of the drawbacks.

The power companies still have divided opinions as to whether single-phase or three-phase motors shall be used for farm installations. Studies of the projects under way will aid in this determination as well as to the desirable line voltages. The question of fair rates is an intricate study for the power companies. We find many schemes being tried to adjust equitably the expense of distribution, maintenance, depreciation, ratios of power costs per kilowatt used, and similar items.

The farm equipment manufacturer will likewise have his series of problems in revamping his products to fit electrical power. The outstanding problem will be that of determining efficiencies and minimum power requirements of various equipments, as was done with ensilage cutters at the University of Wisconsin. Such researches are valuable, no matter what may be the outcome of this series of experimental electrical projects. We should also consider completely modern standards of design in friction-reducing bearings, better lubrication systems and materials. These factors, along with the basic idea of smaller sizes and longer operating periods, where man labor is not a large element, will render farm equipment more satisfactory, whether it be driven by electric or internal-combustion power.

Many problems are indicated in reviewing the applications of electricity to agriculture, which may develop into considerable prominence, such as the effects of electricity on crop production and crop curing. In such cases as have been crudely developed under high costs the results suggest a policy of watchfulness on the part of the farm equipment industry and of readiness to cooperate in experimental research, so that it may rapidly take advantage of electrical progress and produce equipment to keep pace with it.

[1] From an address by O. B. Zimmerman made to the National Association of Farm Equipment Manufacturers at Chicago on Oct. 28. Mr. Zimmerman is assistant to the manager of the experimental engineering department, International Harvester Co., Chicago.

Applicants *Qualified*

The following applicants have qualified for admission to the Society between Oct. 10 and Nov. 10, 1925. The various grades of membership are indicated by (M) Member; (A) Associate Member; (J) Junior; (Aff) Affiliate; (S M) Service Member; (F M) Foreign Member.

ANDERSON, EARL A. (M) general manager of the Michigan lamp division, National Lamp Works of the General Electric Co., 642 Beaubien Street, *Detroit.*

BARROWS, BURTON M. (A) vice-president and treasurer, McFarlan Motor Corporation, *Connersville, Ind.*

BEAUMONT, JAY CHARLES (M) plant engineer for McGraw plant, Kelsey Wheel Co., Inc., *Detroit,* (mail) 2205 St. Clair Avenue.

BIRNN, CHARLES E. (A) master mechanic, Moto-Meter Co., Inc., Long Island City, N. Y., (mail) 3407 38th Street, *Elmhurst Manor, N. Y.*

BJORCK, NILS G. (M) chief engineer, Lange Motor Truck Co., Fifth and Hamilton Avenues, *Pittsburgh.*

BRAID, ARTHUR F. (M) sales manager and metallurgical engineer, Metal & Thermit Corporation, 120 Broadway, *New York City.*

BRIGGS, SIDNEY A. (A) manager, Western Motors Co., 1058 South Flower Street, *Los Angeles.*

BROWN, KENNETH COTTON (A) assistant to general manager, Steam Vehicle Corporation, *Allentown, Pa.*

CARLSON, LESTER A. (A) service manager, Mack-International Motor Truck Corporation, *Columbus, Ohio,* (mail) 71 West Como Street.

COLE, F. HARRISON (A) Motor Improvements, Inc., 365 Frelinghuysen Avenue, *Newark, N. J.*

CROOKS, LAURENCE (J) research assistant, Mason Engineering Laboratory, Yale University, New Haven, Conn., (mail) 28 Pomeroy Terrace, *Northampton, Mass.*

DANIELSON, ARCHIBALD G. (M) assistant chief engineer, Diamond T Motor Car Co., *Chicago,* (mail) 1413 North Luna Avenue.

DINGLEY, BERT (A) service manager, Stutz Motor Car Co. of America, Inc., 10th Street and Capitol Avenue, *Indianapolis.*

DOWNEY, LIEUT. HUGH C., (S M) aviator and engineer officer, Air Service, McCook Field, *Dayton, Ohio.*

DUNN, ARTHUR (A) president and director, Anti-Stall, Inc.; president, director, Capitol Machine Co., Inc., 100 East 42nd Street, *New York City,* (mail) Anti-Stall, Inc.

EDISON STORAGE BATTERY CO. (Aff.) *Orange, N. J.*
Representative: Allen, E. W., sales engineer.

FAIRMAN, RALPH COULTER (A) automotive engineer, 4114 Hemlock Street, *Indiana Harbor, Ind.*

GEIGER, D. HEBER (M) sales engineer, Parish Mfg. Corporation, *Reading, Pa.*

HANNOVER, POUL (J) c/o A. Engel, Vacuum Oil Co., 247 Park Avenue, *New York City.*

HOPE, ELLIS (J) motor truck draftsman, National Steel Car Corporation, Ltd., *Hamilton, Ont., Canada,* (mail) 110 Kensington Avenue, North.

HUBNER, WILLIAM H. (J) automotive engineer, Mellon Institute, *Pittsburgh,* (mail) 5743 Aylesboro Avenue.

HUFFERD, GEORGE H. (A) experimental engineer, Steel Products Co., *Detroit,* (mail) 3603 Helen Avenue.

KEARNEY, DANIEL P. (A) mechanical engineer, Eclipse Machine Co., 960 West Church Street, *Elmira, N. Y.*

KEYS, C. M. (A) president, Curtiss Aeroplane & Motor Co., Inc., Garden City, N. Y., (mail) 60 Broadway, *New York City.*

KORTE, A. C. (J) draftsman, Moon Motor Car Co., *St. Louis,* (mail) 4348-A College Avenue.

KYLE, GEORGE LANE (M) electrical engineer, U. S. Light & Heat Corporation, *Niagara Falls, N. Y.,* (mail) 310 Ferry Avenue.

LAAS, A. G. (J) engineering representative, Locomobile Co. of America, Bridgeport, Conn., (mail) c/o Continental Motors Corporation, *Muskegon, Mich.*

LAMBERT, A. L. (M) chief engineer, Heintz Mfg. Co., Front and Olney Avenues, *Philadelphia.*

LIGHTON, L. E. (A) manager of automotive manufacturers sales, Electric Storage Battery Co., 19th Street and Allegheny Avenue, *Philadelphia.*

LUDINGTON, C. T. (A) president, B. B. T. Corporation of America; president, Ludington Exhibition Co., 820 Atlantic Building, *Philadelphia,* (mail) Ludington Exhibition Co.

MACFARLAND, H. B. (M) Art Work Shop, 828 East Ferry Street, *Buffalo.*

MCCONKEY, M. W. (A) patent attorney, Bendix Corporation, Chicago, (mail) 418 Greenleaf Avenue, *Wilmette, Ill.*

MCNEISH, ROBERT H. (A) automotive engineer, City of Los Angeles fire department, Los Angeles, (mail) Box 1, Route 1, *Van Nuys, Cal.*

MILNE, ALEXANDER (M) metallurgical engineer, Jones & Laughlin Steel Corporation, *Pittsburgh.*

MOSER, H. C. (A) assistant general manager, Chicago Motor Coach Co., 4711 East Ravenswood Avenue, *Chicago.*

MULLER, OTTO G. (J) draftsman, International Motor Co., Long Island City, N. Y., (mail) 810 West 183rd Street, *New York City.*

NELSON, F. R. (J) chief draftsman, Cotta Transmission Corporation, *Rockford, Ill.,* (mail) 1711 Eighth Street.

NELSON, JOHN S. (A) service engineer, Buda Co., *Harvey, Ill.,* (mail) 15,532 Turlington Avenue.

NOTTINGHAM, A. R. (M) designer and mechanical engineer, Continental Motors Co., *Detroit,* (mail) 19,185 Charleston Avenue.

PETERSON, JOHN EDWARD (A) general manager, assistant secretary and director, Waterbury Steel Ball Co., *Waterbury, Conn.,* (mail) 380 Willow Street.

PRENTIS, JOSEPH N. (M) engineer, Cadillac Motor Car Co., *Detroit,* (mail) 3347 Philadelphia Avenue, West.

PRESCOTT, FRANK H. (M) assistant chief engineer, Remy Electric Co., *Anderson, Ind.,* (mail) 1025 Hendricks Street.

PRITCHARD, EUGENE R. (A) assistant engineer, Commercial Truck Co., Philadelphia, (mail) 812 Gilhem Street, *Lawndale, Philadelphia.*

REPLOGLE, JAMES B. (M) Nizer Corporation, *Detroit,* (mail) 2989 Vicksburgh Avenue.

ROSE, HANS (A) metallurgist, Locomobile Co. of America, Inc., 2 Main Street, *Bridgeport, Conn.*

RUDE, T. M. (A) sales manager, Bundy Tubing Co., *Detroit,* (mail) 1982 Leslie Avenue.

SAMPSON, FREDERICK WILLIAM (J) student engineer, Continental Motors Corporation, *Detroit,* (mail) 111 Putnam Street.

SANBORN, WALDE H. (A) service manager, Star Service Station, Inc., Lawrence, Mass., (mail) 126 East Street, *Methuen, Mass.*

SANDERS, R. C. (J) laboratory assistant, General Motors Research Corporation, *Detroit,* (mail) 675 Pallister Avenue.

SMITH, JAMES W. (A) superintendent of the Standard plant, Torrington Co., Torrington, Conn., (mail) South Street. *Litchfield, Conn.*

SQUIRES, JOHN (M) Chrysler Corporation, Oakland Avenue, *Detroit.*

TAYLOR, LIEUT-COL. BRAINERD (S M) Quartermaster Corps, War Department, City of Washington, (mail) c/o F. L. Cady, Mansfield, Mass.

TAYLOR, SAMUEL WILLIAM (M) general superintendent, Maxwell Motor Corporation, *Dayton, Ohio,* (mail) 1753 Radcliffe Road.

THAYER, EUGENE V. R. (A) chairman of the board, Stutz Motor Car Co., Indianapolis, (mail) 90 Wall Street, *New York City.*

TOWNE, O. B. (A) commissioner, National Battery Manufacturers Association, 17 West 42nd Street, *New York City.*

WALCOTT, ALLAN P. (A) industrial mechanical engineer, 161 Bunker Hill Avenue, *Waterbury, Conn.*

WEIGAND, G. F. (A) sales engineer, Spicer Mfg. Corporation, South Plainfield, N. J., (mail) 44 Elmora Avenue, *Elizabeth, N. J.*

WILLIAMS, HARRY S. (A) assistant superintendent of equipment, Department of Street Railways, *Detroit,* (mail) 239 Eason Avenue.

WILSON, J. F. (M) body engineer, Chevrolet Motor Co., General Motors Building, *Detroit.*

Applicants *for* Membership

The applications for membership received between Oct. 15 and Nov. 14, 1925, are given below. The members of the Society are urged to send any pertinent information with regard to those listed which the Council should have for consideration prior to their election. It is requested that such communications from members be sent promptly.

ADAMS, WILLIAM R., superintendent, International Motor Co., *Plainfield, N. J.*

ATKINSON, HARLAND B., draftsman, Paige-Detroit Motor Car Co., *Detroit.*

BEACHAM, ANSEL F., shop foreman, S. N. Harris, *Savannah, Ga.*

BRATTON, LIEUT. ANDRAL, Second Field Artillery, *Fort Bragg, N. C.*

BROWN, R. W., in charge of engineering laboratory, Firestone Tire & Rubber Co., *Akron, Ohio.*

BUHLMANN, KARL, engineering advisor to the Department of State, Reichspostministerium, *Munchen, Germany.*

CALLAHAN, R. C., research assistant, General Motors Corporation Research Laboratories, *Detroit.*

CLARK, RONALD, managing director, Société Anonyme Française North East, *Paris, XVII, France.*

COSTELLO, W. F., production manager, Stanley Works, *New Britain, Conn.*

COX, DONALD S., research engineer, Pierce-Arrow Motor Car Co., *Buffalo.*

CRAWFORD, FREDERICK C., general manager, Steel Products Co., *Detroit.*

CUTTING, HEYWARD, accessory manufacturer, Windsor Motor Products Co., *New York City.*

DALE, JOSEPH S., JR., foreman of engine shop, Marine Garage, *New York City.*

DAVIDSON, G. GRAHAM, draftsman, Consolidated Aircraft Corporation, *Buffalo.*

DAY, BERNARD INCLEDON, design engineer, Rolls-Royce, Ltd., *Derby, England.*

DIXON, J. F., proprietor, J. F. Dixon, *Los Angeles.*

DOEPEL, OTTO J., experimental and equipment engineer, Champion Porcelain Co., *Detroit.*

DRAKE, L. P., president, J. A. Drake & Sons, Inc., *Reedley, Cal.*

DREXEL, DEFORREST W., rail-car engineer, Mack plant, International Motor Co., *Allentown, Pa.*

EITEL, WILLIAM C., airplane inspector, Procurement Section, Air Service, *New York City.*

ERNST, PAUL J., designer, International Motor Co., *New Brunswick, N. J.*

FLOWER, ALPHEUS, engineer, Dodge Bros., Ltd., *London N. W. 10, England.*

FORBERGER, STEPHEN A., designer, Wright Aeronautical Corporation, *Paterson, N. J.*

GEEN, C. P., consultant and experimenter, 935 Hyde Street, *San Francisco.*

GIPE, T. E., manager, gas engine department, Wright Machine Co., *Owensboro, Ky.*

GLITZENHIRN, GEORGE, instructor in shop practice, University of Michigan, *Ann Arbor, Mich.*

GREEN, KANE S., president, Automobile Club of Philadelphia, *Philadelphia.*

GUERRERA, CARMIN A., special dynamics research, General Motors Corporation Research Laboratories, *Detroit.*

HANNEWALD, BURTON, mechanical engineer, Charles D. Schmidt Corporation, *New York City.*

HAUSSER, CURT FRED, chief engine inspector, Waukesha Motor Co., *Waukesha, Wis.*

HILL, JOSEPH B., sales engineer, Ensign Carburetor Co., *Los Angeles.*

HUGHES, VICTOR, research engineer, General Motors Corporation Research Laboratories, *Detroit.*

JOYCE, WILLIAM J., foreman of ignition repair department, Public Service Transportation Co., *Irvington, N. J.*

KILPATRICK, J. R., inspector, automotive division, Westinghouse Air Brake Co., *Boston.*

KING, CHARLES H., draftsman, Clark Tructractor Co., *Battle Creek, Mich.*

KOSTER, WILLIAM A., draftsman, Cruban Machine & Steel Corporation, *New York City.*

LEMMER, CHARLES G., sales engineer, Steel Products Co., *Detroit.*

LEPKOS, JAY, special representative, Firestone Tire & Rubber Co., *San Francisco.*

LOEW, CHARLES F., works manager Loew Mfg. Co., *Cleveland.*

LOGUE, CHARLES H., consulting engineer, *Syracuse, N. Y.*

LONGAN, LOUIS W., automotive engineer, Link-Belt Co., *Indianapolis.*

MCGRATH, ROBERT H., assistant to vice-president, Eberhard Mfg. Co., *Cleveland.*

MCGREGOR, FIRST LIEUT. DUNCAN G., Springfield Armory, *Springfield, Mass.*

MARMOY, ARTHUR FRANCIS, purchasing agent, Luxor Cab Mfg. Corporation, *Framingham, Mass.*

MARSHALL, THOMAS C., vice-president, Kelly-Springfield Tire Co., *New York City.*

MEHAFFEY, J. J., master mechanic, Consolidated Textile Corporation, *Lynchburg, Va.*

NIVEN, A. M., engineer designer, Continental Motors Corporation, *Detroit.*

PARDOE, EDWARD S., superintendent of motorcoach operations, Capital Traction Co., *City of Washington.*

PENNINGTON, W. W., district manager, U. S. Light & Heat Corporation, *Niagara Falls, N. Y.*

PITMAN, JOHN HENDERSON, automotive mechanics instructor, Turlock Union High School, *Turlock, Cal.*

PRABEL, IRWIN A., motor-truck designer, Freeman Motor Co., *Detroit.*

QUACKENBUSH, CLAUDE F., head of department of mechanical and automotive engineering, Polytechnic College of Engineering, *Oakland, Cal.*

RHODES, LIEUT. BRAXTON, Naval Air Station, *Pensacola, Fla.*

RIGNEY, HOWARD C., superintendent, Russell Burdsall & Ward Bolt & Nut Co., *Port Chester, N. Y.*

ROSS, H. E., purchasing agent, Ross Carrier Co., *Benton Harbor, Mich.*

SANFORD, WILLIAM W., service engineer, Skinner Automotive Device Co., Inc., *Detroit.*

SARGENT, RICHARD B., experimental department, International Motor Co., *Allentown, Pa.*

SCHNEIDER, W. C., draftsman, Reo Motor Car Co., *Lansing, Mich.*

SCOTT, LEROY J., sales manager, Steel Products Co., *Detroit.*

SNIEGOWSKI, J. S., chief engineer, Stearns Motor Mfg. Co., *Ludington, Mich.*

SOMMERS, W. J., division sales manager, White Co., *Long Island City, N. Y.*

TAYLOR, PHILIP B., assistant chief powerplant engineer, Wright Aeronautical Corporation, *Paterson, N. J.*

TEPPER, MAURY M., president, Leading Cab Co., Inc., *New York City.*

THIEL, WILLIAM CARL, production manager, Waukesha Motor Co., *Waukesha, Wis.*

TOTMAN, E. P., division supervisor of maintenance, Western Union Telegraph Co., *New York City.*

TOWNSEND, LIEUT. GUY DUKER, aeronautical engine laboratory, Naval Aircraft Factory, League Island Navy Yard, *Philadelphia.*

VOGLESONG, G. E., service manager, Wills Sainte Claire, Inc., *Marysville, Mich.*

WALKENHORST, W., service manager, Mack-International Motor Corporation, *Cincinnati.*

WATSON, MATTHEW S., superintendent of equipment, Colonial Motor Coach Corporation, *Watertown, N. Y.*

WHITING, CHARLES HERBERT, methods engineer, De Jon Electric Corporation, *Poughkeepsie, N. Y.*

WOLFLEY, CARL H., vice-president, Wolfley Automobile Co., *St. Joseph, Mo.*

ZIMMER, GEORGE B., chief draftsman, International Motor Co., *Plainfield, N. J.*

ZIMMERMAN, JOHN CLARK, manufacturers' sales representative, Goodyear Tire & Rubber Co., *Detroit.*

THE JOURNAL OF THE SOCIETY OF AUTOMOTIVE ENGINEERS

INDEX TO VOLUME XVII, JULY-DECEMBER, 1925

Charles Myers taking a turn on his way to victory and a new record on the Pike's Peak Mountain climb.

FEDERAL-MOGUL *Equipped* CHANDLER *Sets* NEW RECORD!

Charles Myers with a Pike's Peak motored Chandler Six not only won the Pike's Peak Mountain climb, but he bettered the best previous record by nearly one-half minute. Hats off to Chandler! The record is a credit to engineering skill and to the stamina of the materials that went into this car.

That Federal-Mogul engine bearings were chosen as standard equipment by the designers of this record making car, we believe, is a credit to the bearings.

The countless races, endurance runs and rigid tests that Federal-Mogul products have starred in, the long list of over 150 automotive manufacturers using them as standard pile up such a mass of evidence in their favor and constitute such positive proof of their quality and reliability that their outstanding leadership is easily understood. They lead by honest merit.

THE FEDERAL-MOGUL COMPLETE LINE

Bronze Back, Babbitt Lined Bearings

Die Cast Babbitt Bearings and Bushings

Bronze Bushings

Bronze Washers

Bronze Castings

Babbitt Metals

Bronze Cored and Solid Bars

FEDERAL-MOGUL CORPORATION
A Consolidation of the FEDERAL BEARING AND BUSHING CORPORATION and the MUZZY-LYON CO.
DETROIT, MICHIGAN

Mogul FEDERAL

Radio Microphone Principles

were adapted by Timken engineers to test bearings regularly for silence—independently of human ears.

It is another example of the relentless effort for betterment constantly applied to Timken production and product.

The scope of Timken research and development is made possible by Timken resources.

THE TIMKEN ROLLER BEARING CO., CANTON, O.

Factories (for the United States)... Columbus—Canton, Ohio... Capacity—125,000 Timken Bearings daily... Owning and operating electric furnaces, blooming mills, bar, tube and rod mills.

Personal Notes of the Members

Items regarding changes in business connections, promotions, etc., are desired from the membership for insertion in these columns. This will enable members to keep their friends informed of their whereabouts and will also assist in keeping the records of the Society up to date.

Daniel F. Ahlberg, who until recently was sales engineer and designer for the Clark Cutter Co., Detroit, has become purchasing agent for the Michigan Tool Co., also of Detroit.

John A. Anderson has been made president of the Denton & Anderson Co., Detroit. He was formerly manager of the Michigan district for this organization.

J. G. Anderson has severed his connection with the Checker Cab Mfg. Co., Kalamazoo, Mich., where he held the position of factory manager. No announcement has been made regarding his plans for the future.

A. E. W. Babington is now salesman for the W. B. Deyo Co., Detroit.

Loy E. Barton has severed his connection with the University of Arkansas, Fayetteville, where he was an instructor in the engineering department. His plans for the future have not been made known.

J. J. Basch has been appointed Pittsburgh sales representative for the Oakley Chemical Co., New York City.

Harry O. Breaker, who was formerly president and treasurer of the American Industrial Furnace Corporation, Boston, is now vice-president of the General Furnace Co., Chicago.

Claude S. Briggs has been appointed general manager of the motor-car body division of the Gotfredson Corporation, Detroit.

Frank Briscoe, who was previously president of the Briscoe Devices Co., Pontiac, Mich., now holds a similar office with the General Accessories Co., also of Pontiac.

H. L. Brownback, vice-president and general manager of the Brownback Motor Laboratories, Inc., New York City, has been in Europe for the last few months, investigating the design and construction of light cars and engines in England, France and Germany.

Fred W. Cederleaf has become associated with the Ternstedt Mfg. Co., Detroit, as assistant factory manager of the Shepard art metal division.

E. M. Champion has been transferred from the Detroit plant of the American Motor Body Corporation, where he was manager, to Philadelphia to act in the capacity of general factory manager.

Harold W. Cheel, who until recently was sales engineer for Egleston Bros., Inc., Long Island City, N. Y., has been made secretary and treasurer of the Ever Hot Heater Sales Co., New York City.

Harold T. Christensen has been made marketing cost analyst with headquarters in Minneapolis, for the Standard Oil Co. of Indiana, Chicago, having previously been sales correspondent for this company.

(*Continued on p.* 4)

PERSONAL NOTES OF THE MEMBERS

Continued

P. C. Cloyd has accepted a position as engineer for the Liberty Transformer Co., Chicago. He was formerly affiliated with Babson Bros., also of Chicago.

Joseph F. Collins, is no longer secretary and chief engineer of the Philadelphia Motor Coach Co., Philadelphia, but has opened an office in that city as consulting engineer.

Edgar M. Costley has accepted the position of service promotion representative for the Chevrolet Motor Co., Charlotte, N. C. Formerly he attended the Georgia School of Technology, Atlanta.

E. B. Craft who has been chief engineer of the Western Electric Co., New York City, since 1922, has been appointed executive vice-president of the Bell Telephone Laboratories, Inc., also of New York City.

Robert W. Davis, is now mechanical engineer for the F. L. Smithe Co., Inc., New York City. Prior to establishing this connection he was associated with the Dickinson Cord Tire Corporation, also of New York City, in a similar capacity.

Karel De Lange has accepted a position as engineer with the International Harvester Co., Chicago, and will be located at its Springfield, Ohio, plant. Previously he held a similar position with Graham Bros., Detroit.

C. H. Dengler, who was formerly engineer for the Fox Holding Co., Philadelphia, has become affiliated with the International Harvester Co., Chicago, and is located in its coach factory at Springfield, Ohio.

Edgard C. De Smet has been appointed experimental body engineer for the Briggs Mfg. Co., Detroit. His previous business connection was body designer for Dodge Bros., also of that city.

N. J. den Tex has joined the engineering department as designer of the Rolls-Royce Co. of America, Springfield, Mass.

N. S. Diamant has been appointed consulting engineer of the McCord Radiator & Mfg. Co., Detroit. He formerly acted in a similar capacity for the National Radiator & Mfg. Corporation, also of that city.

Robert I. Dick, who was until recently engineer for the Hart-Parr Co., Charles City, Iowa, now holds a similar position with the Buhl Co., Chicago.

A. Y. Dodge, who was previously affiliated with the Perrot Brake Corporation, South Bend, Ind., has been appointed chief engineer for the Bendix Brake Co., also of South Bend.

Ralph P. Donjan is no longer associated with the Uppercu-Cadillac Motor Car Co., New York City, but is now affiliated with G. Albert Lyon, Asbury Park, N. J.

George H. Duck has been made general manager of the Delaware Steel Products Co., Philadelphia. He was formerly business manager for the *Commercial Car Journal,* published by Chilton Co., also of Philadelphia.

Louis B. Ehrlich, who was formerly chief engineer of Gray & Davis, Inc., Boston, has accepted a similar position with the American Bosch Magneto Corporation, also of Boston.

Benjamin M. Engesser has become affiliated with the Wisconsin Telephone Co., Milwaukee. Previously he was associated with the Allis-Chalmers Mfg. Co., of that city.

F. B. Farquharson has been appointed instructor in engineering in the University of Washington, Seattle. He was formerly research engineer for the Boeing Airplane Co., also of Seattle.

(*Continued on p. 6*)

PERSONAL NOTES OF THE MEMBERS

Continued

Daniel H. Fenton previously manager of the tire testing department of the Fisk Rubber Co., Chicopee Falls, Mass., has been made technical engineer of the company.

Ralph M. Gaston has accepted a position as factory manager for the Mall Tool Co., Chicago. Prior to this he was production engineer for the Continental Oil Burner Corporation, Chicago.

Herbert Gfroerer is no longer associated with the Cadillac Motor Car Co., Detroit, but has joined the sales department of Dodge Bros., Inc., also of Detroit.

W. E. Gossling has severed his connection with the Prest-O-Lite Co., Inc., Indianapolis, where he was engineer in the storage-battery division. No announcement has been made regarding his future plans.

William S. Gould has been elected president of the Gould Storage Battery Co., New York City. He was formerly vice-president of the company.

Louis C. Huck has severed his connection with the Sheldon Axle & Spring Co., Wilkes-Barre, Pa., where he was manager of the Huck axle division. His plans for the future have not been made known.

Daniel M. Jack has been appointed assistant superintendent of aircraft division of the Pratt & Whitney Aircraft Co., Hartford, Conn. Prior to establishing this connection he was superintendent and service manager of du Pont Motors, Inc., Moores, Pa.

Chester C. Jackman has become affiliated with Ruggles Trucks, Inc., Miami, Fla.

Ira L. Johnson, who was formerly engineer for Aro Tractor Co., Minneapolis, has become field engineer for the Minneapolis Steel & Machinery Co., also of that city.

C. S. Kegerreis, is no longer research associate in the carburetion division of Purdue University, West Lafayette, Ind., but is pursuing post graduate work in the automotive laboratory of the University of Michigan, Ann Arbor.

V. W. Kliesrath has been made vice-president and general manager of the Bragg-Kliesrath Corporation, Long Island City, N. Y.

F. W. Kulicke, who was previously sales engineer for the Atwater Kent Mfg. Co., Philadelphia, has become affiliated with the Budd Wheel Co., Detroit.

George L. McCain has been appointed assistant research engineer for Dodge Bros., Detroit.

John McGeorge, who was formerly consulting engineer in the works engineering and maintenance department for the Oakland Motor Car Co., Pontiac, Mich., has been made works engineer for this company.

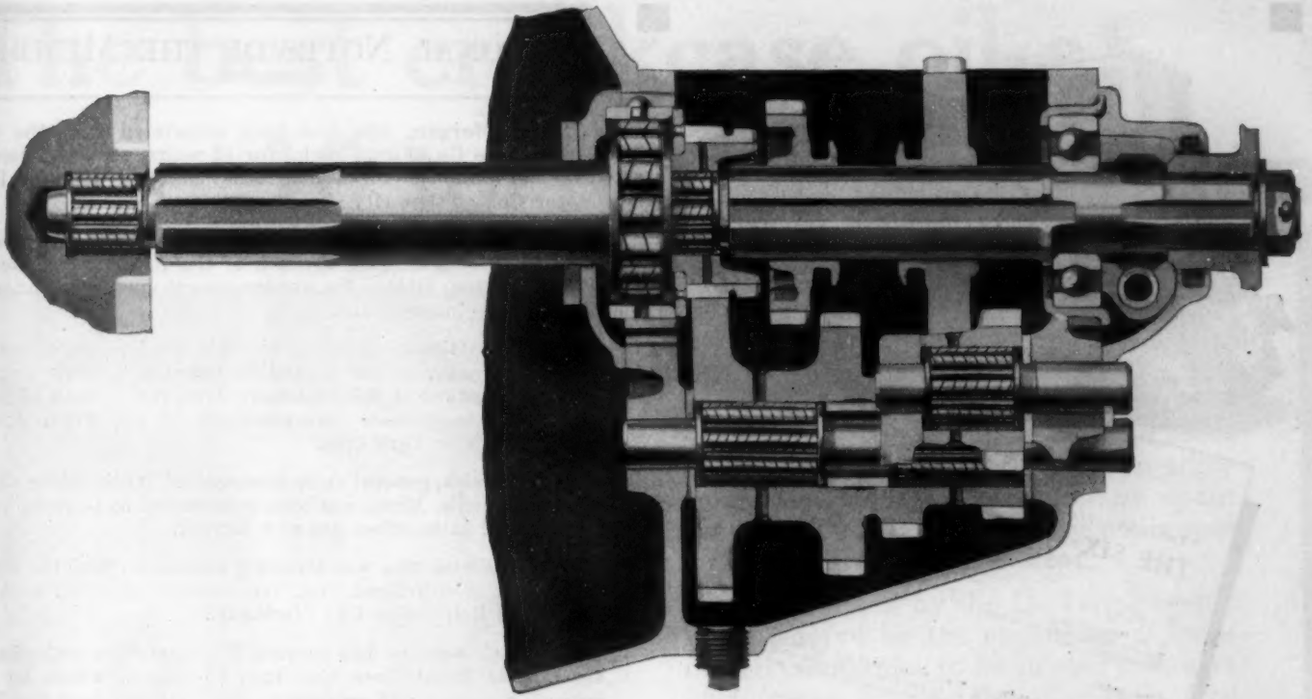
W. H. Marty has rejoined the Wright Aeronautical Corporation, Paterson, N. J., as chief inspector. He was previously assistant chief inspector for this organization.

George J. Mercer, secretary and sales manager of the Model Body Corporation, Detroit, has severed his connection with this organization, and will devote all his time to consulting engineering work in that city.

Fritz Mitschke, who was formerly designer for the International Motor Co., Plainfield, N. J., has accepted a position as tool designer for the White Motor Truck Co., Cleveland.

Orion G. Moe is now enrolled as a graduate student in aeronautic engineering at the Massachusetts Institute of Technology, Cambridge. He was formerly draftsman doing detail and design work for Gar Wood, Inc., Detroit.

(*Concluded on p.* 8)



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Manufacturers in increasing numbers are adopting Hyatt Roller Bearings for their transmissions because time and experience have shown them to possess in high degree these superior advantages:

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By building your transmissions fully Hyatt-equipped you secure all of the advantages listed herewith. Hyatt Bearings simplify production operations and thereby reduce costs. You will find, too, as other manufacturers have already found, that Hyatt Bearings build and keep the profitable good will of both dealers and customers through their appreciation of quiet, economical and enduring transmission performance.

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PERSONAL NOTES OF THE MEMBERS

Concluded

Harry Morgan, who has been associated with the Flint Motor Axle Co., Flint, Mich., for 12 years, resigned recently as chief engineer to become axle engineer for the Buick Motor Co., of that city.

Alan L. Morse has resigned as assistant aeronautic engineer in the engineering division of the Air Service, McCook Field, Dayton, Ohio. No announcement has been made regarding his future plans.

Louis H. Palmer, who until recently was vice-president and general manager of the United Railways & Electric Co., and general manager of the Baltimore Transit Co., both of Baltimore, has been made vice-president of the Fifth Avenue Coach Co., New York City.

W. J. Parrish, general sales manager of Wills Sainte Claire, Inc., Marysville, Mich., has been transferred to Detroit, where the general sales offices are now located.

B. G. Parsons, who was formerly associated with the Perrot Brake Co., South Bend, Ind., has become affiliated with the Cincinnati Ball Crank Co., Cincinnati.

Walter C. Robbins has severed his connection with the International Metal Hose Co., Inc., Cleveland, where he was general manager and secretary. No announcement has been made regarding his future plans.

Maurice Sainturat, who was previously engineer for the Automobiles Delage, Paris, France, is now chief engineer for the Société des Automobiles Donnet Zedel, Nanterre, France.

W. J. Schlinger has been appointed manager of automotive sales for E. I. duPont de Nemours & Co., Wilmington, Del., and will make his headquarters at Detroit. Prior to making this connection he was associated with the Flint Varnish & Color Works, Flint, Mich.

Malcolm F. Schoeffel, who formerly attended the Massachusetts Institute of Technology, Cambridge, has become affiliated with the Bureau of Aeronautics, Navy Department, City of Washington.

F. M. Slough, who was associated with Richey, Slough & Fales, patent attorneys at Cleveland, has opened an office in the B. F. Keith Building, that city.

Earl H. Smith has been appointed chief inspector for the Olds Motor Works, Lansing, Mich.

Kenneth D. Vosler, who was formerly factory manager for the Hamilton Aero Mfg. Co., Milwaukee, is now factory superintendent for the Edo Aircraft Corporation, College Point, N. Y.

W. B. Wachtler is no longer sales manager of the industrial division of the Hyatt Roller Bearing Co., Harrison, N. J., but has been appointed assistant to the president of the General Motors Export Co., New York City.

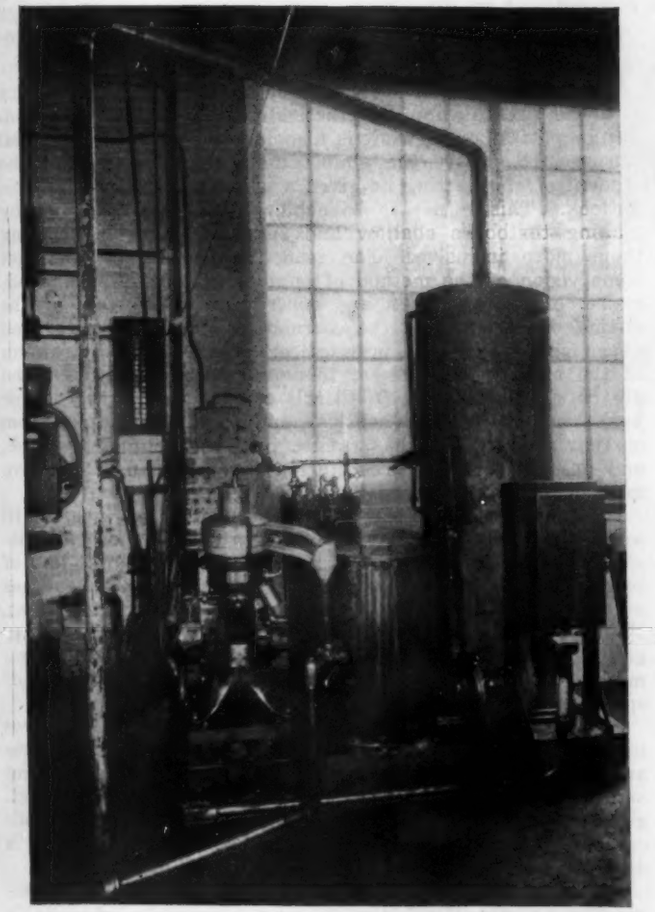
O. W. Warner, who was formerly service manager for the Roamer Motor Car Co., Kalamazoo, Mich., has become research engineer in the motorbus department of the International Harvester Co., Springfield, Ohio.

Lieut. H. E. Weihmiller is now stationed at Brooks Field, San Antonio, Tex., and is taking a course in the Flying School. He was formerly junior aeronautic engineer in the Air Service at McCook Field, Dayton, Ohio.

R. R. Whittingham has been transferred from the Philadelphia office of the Vacuum Oil Co. to New York City, following his appointment as Eastern manager of the commercial car division of the company.

George H. Woodfield has accepted a position as body designer for Brunn & Co., Buffalo. He was formerly chief engineer for the American Body Co., also of Buffalo.

The best crankcase oil at 10 to 18 cents a gallon



The Yellow Cab Company, of Philadelphia, has used the De Laval Crankcase Oil Reclaiming Outfit shown above for about six months. It has recovered about 1000 gallons of oil each month and the total cost of recovery has averaged one-third the cost of new oil. Purification is so complete that new oil and reclaimed oil are stored in a common tank. Recovery averages 88%, the remaining 12% consisting of dilution, carbon, etc.

With the De Laval Crankcase Oil Reclaiming Outfit you can reduce the cost of lubricating the motors of your trucks, cabs or buses 40 to 70 per cent —depending on the size of your fleet and the price you pay for oil. In addition, you can use better oil or drain oftener and still save money while materially reducing engine wear.

Oil reclaimed by the De Laval Outfit is considered by the engineers of leading oil companies to be in every way as efficient as brand-new oil. It is free from carbon and other abrasive matter and tests practically the same as new oil as regards flash, fire and viscosity.

For all practical purposes, the oil coming from the De Laval Reclaiming Outfit is re-refined. Yet the process is so simple and the Outfit so fool-proof that it is easily handled by ordinary garage help—often in spare time.

If you are a fleet operator you can probably save enough oil to pay for the De Laval Outfit in a year or less. If you are a truck, cab or bus manufacturer it will pay you to encourage the use of the Outfit to your customers. It helps your product give better service at lower cost.

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Notes and Reviews

This column, which is prepared by the Research Department, gives brief items regarding technical books and articles on automotive subjects. As a general rule, no attempt is made to give an exhaustive review, the purpose being to indicate what of special interest to the automotive industry has been published.

Principles of Machine Design. By C. A. Norman. Published by Macmillan Co., New York City. 710 pp.; 585 illustrations.

The author of this book has for his obvious and primary aim the presentation of practically valid rules and good-design patterns; his work is also inspired by a broad social purpose, to satisfy the almost universal demand that the student of engineering be given a wider mental training and outlook. This is not to be achieved, as he points out, by making textbooks shallow and superficial, but by making them more inclusive. The students are expected to get some vision of the method of engineering and scientific advance, of the struggles and controversies involved, of the sifting of evidence, of the correlation of mathematical and experimental fact with practical experience, of the straining of the mind to the utmost to penetrate a complicated and abstruse situation. To fulfill this composite aim, the author has included both mathematical analyses and examples from current practice. He has ranged over the field of research, and has selected for presentation investigations that have marked the prominent advances in engineering progress.

A consideration of the author's treatment of gears will indicate the method followed. After a short general discussion of gear history, he lays down the fundamental law of tooth action—that the common normal to two tooth outlines at their point of contact must go through the pitch point. He then takes up the principles of involute-gear generation, giving both the mathematical basis, and manufacturing methods now in use. Gear materials and the strength of spur-gears are the final subjects treated in the chapter.

After a chapter devoted to helical gears, the author turns to bevel-gears. He analyzes the methods of selecting cutter and formative tooth numbers, and the layout of converging and parallel-depth teeth. In describing the strength of bevel-gears, he cites Lewis's formula, and several practical applications of it. A sample computation of bevel-gears, and a discussion of spiral-bevel gears closes the chapter.

Some of the subjects covered under the section on worm-gearing are the Hindley worm, the designation of suitable materials for gears, analysis of side-thrust, pressure-angles, load on worm-gears, and several concrete problems in worm-gearing.

Other chapters having a bearing on automotive design are those on materials, leaf and coil springs, on piston-pins, connecting-rods and crossheads, cranks and crankshafts, bearings, clutches and brakes.

Dyke's Automobile and Gasoline Engine Encyclopedia. By A. L. Dyke. Published by Goodheart-Willcox Co., Inc. 1233 pp.; 4200 illustrations.

The 14th edition of Dyke's Automobile and Gasoline Engine Encyclopedia is the first revision of this book since 1922. Trucks and tractors, as well as automobiles, are included in the compilation. The method of treatment is first to outline the fundamental principles of the part, second to describe some current types and third to analyze troubles and indicate remedies. This compendium of information is intended to find its readers among students, car-owners and repair men. For the new edition, 512 pp. of reading matter and 221 illustrations have been changed. More than 1200 lines have been added to the index, bringing the total up to 15,000 lines. Among the new features on which emphasis is placed are several colored charts.

Sixteen divisions make up the book: general assembly, the

(*Continued on p.* 12)

NOTES AND REVIEWS

Continued

gasoline engine, carburetion, cooling and lubrication, ignition, engine-starters, electric generator, electrical systems, troubles, storage-battery, tires, operating and care of a car, automobile repairing and adjusting, tractors, miscellaneous subjects, and the Ford automobile.

Vibration in Engineering. By Julius Frith and Frederick Buckingham. Published by MacDonald & Evans, London. 123 pp.; 41 figures.

Vibration in engineering is experienced wherever parts are movable. This is a serious question and the treatment of the subject from both the physical and mathematical standpoint will be of universal interest to engineers studying the problem.

Causes of Vibration, Bodies with and without Natural Periods of Vibration, Examples of Restoring Forces, Different Actions of Disturbing Forces, Diagnosis and Cure for Vibration Troubles and Effects of Vibration on Individuals are some of the subjects treated in Part 1 of the Physical Section. Part 2 deals with the mathematical phase of the vibration problem. Here the authors discuss Simple Harmonic Motion, Damped Vibration, Numerical Example of Damped Vibration of Loaded Spring, Forced Vibrations, Transverse Vibrations of Beams, and Whirling of Shafts.

The authors state that the phenomena dealt with have hitherto not received the attention that they deserve. They also state that information and literature on the subject are scattered and very difficult to coordinate. The reason given is that the right understanding of the subject involves diverse problems in sound, strength of materials and mechanics, as well as physics and mathematics of harmonic motion.

The book contains a bibliography as well as an appendix of hyperbolic functions. A list of symbols used is also given.

Motor Design and Fuel Economy. By C. F. Kettering. Published in *Industrial and Engineering Chemistry*, November, 1925, p. 1115.

According to the author, the hypothetical future car, designed for the delivery of more miles per gallon will be extremely small and light. Completely streamlined, it will have no top, windshield or mud-guards, and only a small radiator. The carbureter and ignition system will be complicated, the latter so arranged that the spark-advance will be automatically adjusted for each speed and load. It will have no fan or electrical equipment. The transmission will have four speeds forward and one reverse, and when in high gear all other gears will be disconnected. Only on the level will the car be able to pull in high gear. When the brakes are not in use they will be entirely free of any contact with the wheels. Mr. Kettering then points out that many of these features would have to be discarded to make the car salable, and cites the high-compression engine as the most promising development for the immediate future.

The Motor Exhibition at Olympia. Published in *Engineering*, (London), Oct. 9, 1925, p. 454; Oct. 16, p. 473, and Oct. 23, p. 504.

Summing up his impressions of the motor-car exhibits shown at Olympia, this reviewer says that British products compare favorably with the Continental in both finish and value; and that they appear to be better than American products from an engineering standpoint, while the value for the money is comparable in the majority of cases. Among special-design developments noted are the wider adoption of superchargers, the increase in straight-eight engines, and the success of the Alvis front-wheel drive. In connection with superchargers, the remark is made that the tendency in engine design has been toward simplification, but that this

(*Continued on p.* 14)

NOTES AND REVIEWS

Continued

course has been abandoned in the effort to get more power for a given cylinder-capacity. Superchargers are conceded a place on sport cars, but their application to touring cars is said to be more problematical, due in part to their noisiness. In the touring-car field, the growing demand for light cars is emphasized. Discussing the popularity of various engine features the author points out that (*a*) the detachable cylinder-head is found now on 85 per cent of cars; (*b*) side-by-side and overhead valves are equally represented; (*c*) more cars are fitted with pump than with thermo-siphon cooling; (*d*) the disc and plate clutch have gradually been replacing the cone type; (*e*) four-speed gearboxes are preferred to the three-speed variety; and (*f*) nearly 80 per cent of cars are fitted with four-wheel brakes.

The author then describes models that either embody departures from the usual practice, or typify some particular design tendency. The 16-hp. Aoeca, for instance, illustrates the steadily increasing popularity of the six-cylinder engine of moderate dimensions; the new Vauxhall and the Daimler, the trend toward sleeve-valves; the Clyno, the reasonable price of the British makes; the Bentley car, with which the world's 24-hr. speed record was broken, a speedy engine; the G. W. K., the one British car with a friction drive; and the Riley, cars of moderate power and high quality.

The Michell Crankless Engine. Published in *The Automobile Engineer*, October, 1925, p. 316.

The new crankless internal-combustion engine is said to have given, in practical operation, results comparing favorably with those of good engines of the orthodox type. For it is also claimed the advantatge of perfect balance with a consequent freedom from vibration. Of the "revolver" type, the engine consists of a number of cylinders arranged in a series around the shaft, with the pistons reciprocating in a direction parallel to the shaft axis. The cylinders are stationary, while the engine-shaft revolves and drives the gear mechanism of the vehicle in the ordinary way. Each piston-head has a tubular extension to which is rigidly attached a yoke or bridge-piece. This member carries two bearing slippers, universally jointed to the pistons, being formed with hemispherical surfaces fitting in spherical cups attached to the outer ends of the piston-tubes already referred to. On their opposite faces, which are plane, the slippers engage with the plane working surfaces of the swash-plate, rigidly attached to the engine-shaft. Angular momentum produced by the action of the piston slippers on the swash-plate produces the smooth running of the engine. Besides the elimination of connecting-rods and flywheels, this engine has novel provisions for lubrication. Bench tests of an eight-cylinder engine of 35-hp. Royal Automobile Club rating showed a mechanical efficiency exceeding 90 per cent. Fitted in a 3150-lb. chassis, this engine gave gasoline and oil consumptions of 20.8 and 1300.0 miles per gal. respectively on a long-distance trial.

Baldwin Builds Diesel-Electric Locomotive. Published in *Railway Age*, Oct. 10, 1925, p. 645.

With a rated capacity of 1000 hp., the Diesel-electric locomotive built by the Baldwin Locomotive Works is said to be the most powerful of its type built in this Country, and to have only one rival abroad, the Lomonosoff. The engine, of the two-cycle solid-injection type, has 12 cylinders arranged in two groups of three pairs each. The pistons in the two cylinders of each pair drive on separate parallel crankshafts. Each pair of cylinders has, however, a common combustion-chamber enclosed by a single head-casting and supplied with fuel through a single injection-nozzle. The six fuel pumps are operated by a camshaft. In the center of each of the two crankshafts, between the two groups of cylinders, is a large herringbone pinion on the end of the

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NOTES AND REVIEWS

Continued

generator-shaft which steps up the crankshaft speed of 450 r.p.m. to 1200 r.p.m. at the generator. The cylinders have a bore of 9¾ in. and a stroke of 13½ in. Operation of the ports in such a way that the scavenging air builds up a pressure of 2½ lb. in the cylinder before compression takes place is mentioned as one special feature of the engine. Another is said to be the use of air from the scavenger blower to cool the pistons.

Block tests of the engine indicate a fuel consumption of 0.40 gal. per hp-hr. at full load, increasing to 0.45 gal. per hp-hr. at half load. The engine has developed a maximum crankshaft speed of 480 r.p.m.

Diesel-Electric Cars for the Canadian National. Published in *Railway Age*, Oct. 17, 1925, p. 695.

Nine Diesel-electric cars, seven single with an over-all length of 60 ft. and two of the articulated type with an over-all length of 102 ft., have been ordered by the Canadian National Railways. William Beardmore & Co., Ltd., London, England, built the engines, which are a modification of its standard airplane engine. They conform to a modified Diesel cycle of the solid-injection four-stroke-cycle type and are arranged with four cylinders in line in the small unit for the 60-ft. car and eight in line in the large unit for the articulated car. The cylinders in both engines have an 8¼-in. bore and a 12-in. stroke and develop 185 b. hp. at 700 r.p.m. in the small unit, and 340 b. hp. at 650 r.p.m. in the larger. The smaller engine weighs 15 lb. per hp. and the larger, slightly more than 16 lb. per hp. The use of high-tensile steels and special alloys makes possible this comparatively low weight. The construction of the cars, their electrical equipment, and the conditions of operation are described in detail in this article.

Nickel and Nickel-Chromium in Cast Iron. By T. H. Wickenden and J. S. Vanick. American Foundrymen's Association Preprint No. 486. Published by American Foundrymen's Association, Chicago. 60 pp.

The authors describe some of the results of an investigation into the properties of and discuss the commercial applications of nickel and nickel-chromium cast iron. Nickel and nickel-chromium cast iron are being used commercially today for rolling-mill parts such as rolls, mill guides, pipe-pending dies, pipe balls; for automobile engine and other cylinder castings; for pistons and piston-rings; for cast-iron cams; for sheet and plate metal forming dies, and in various thin-section castings, notably resistance grids, the amounts used varying from as little as 0.1 per cent—but usually not less than about 0.4 per cent—up to 5.0 per cent of nickel and from 0.0 to 0.5 per cent of chromium.

Initial Temperature and Mass Effects in Quenching. By H. J. French and O. Z. Klopsch. Bureau of Standards Technologic Paper No. 295. Published by Bureau of Standards, City of Washington. 15 pp.

In this report are given results of quenching experiments with high-carbon steels in which the speed of cooling was determined at the center of spheres, rounds and plates of various dimensions quenched from different temperatures into various coolants, such as water, 5-per cent solution of sodium hydroxide, oils and air. The cooling velocity at 720 deg. cent. (1328 deg. fahr.) is taken as the best measure of hardening produced, and relations are developed between this and the size and shape of steel quenched. Knowing the cooling-rate at the center of any one size of the simple shapes quenched in any of the customary quenching media, such as oils and aqueous solutions, the velocity in any other size in such shapes can be closely approximated from the included data when the steel is quenched from any temperature between 720 and 1050 deg. cent. (1328 and 1922 deg. fahr.).

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NOTES AND REVIEWS

Continued

American Society for Testing Materials Tentative Standards for 1925. Published by the American Society for Testing Materials, Philadelphia. 876 pp.

This volume contains the 193 tentative specifications, methods of test, definitions of terms and recommended practices in effect as of Aug. 28, 1925. The standards are termed tentative, since they are being published to elicit criticism before they are formally adopted by the American Society for Testing Materials. The specifications and methods of test, although still in the trial stage of the Society's procedure, represent the latest thought of the committees on the subjects covered, and therefore are finding important applications in the various industries. Since the tentative standards may frequently be used in conjunction with the standards of the Society, the volume is complementary to the Book of American Society for Testing Materials Standards.

Among the recently proposed standards are tentative specifications for carbon-steel car and tender axles; carbon-steel castings for valves, flanges and fittings for high-temperature service; and ferromanganese, ferrosilicon, ferrochromium, and ferrovanadium: tentative methods of sampling ferroalloys, and chemical analysis of ferroalloys; and tentative recommended practice for carburizing and heat-treatment of carburized objects. Tentative methods for nine different tests for petroleum products have been originated in 1925.

Heat Treatment of Cast Aluminum-Copper-Iron-Magnesium Alloy. By Samuel Daniels. Published in *Forging-Stamping-Heat Treating*, October, 1925, p. 346.

After expressing the opinion that the heat-treating of piston aluminum-alloys has not been widely appreciated, the author describes some of the research on this subject undertaken by the metals branch of the material section, Engineering Division of the Air Service. Some of the conclusions arrived at are given below.

The strength and hardness of the sand-cast 88.50-per cent aluminum—10.00-per cent copper—1.25-per cent iron—0.25-per cent magnesium alloy may be increased to about 35,000 lb. per sq. in. and 120, respectively, by a heat-treatment that involves heating at 925 deg. fahr. for 5 hr., quenching in boiling water, and aging at 300 deg. fahr. for 16 hr. or at 400 deg. fahr. for 2 hr. Quenching from temperatures of much less than 925 deg. fahr. results in inferior strength but not necessarily lower hardness. Very little is to be gained by soaking the alloy at 925 deg. fahr. for more than 5 hr. At temperatures much in excess of 975 deg. fahr. the alloy starts to melt. The presence of this condition cannot be detected from the hardness and the quenched alloy, but it can be deduced from the inferior strength of test specimens which should always be heat-treated with castings. Air-quenching produces less uniformity and lower ultimate strength than does quenching in boiling water. The percentage of elongation of the alloy in any condition of treatment is practically nil. The metallography of the alloy is of much value as a method of control to proper heat-treatment.

Flow in a Low-Carbon Steel at Various Temperatures. By H. J. French and W. A. Tucker. Bureau of Standards Technologic Paper No. 296. Published by Bureau of Standards, City of Washington. 12 pp.

This report relates to flow or elongation in a 0.25-per cent carbon-steel subjected to a fixed total load in tension at an approximately constant temperature within the range of from 70 to 1100 deg. fahr. The character of flow is described, and the factors governing selection of maximum allowable stresses are discussed for service in which long life and freedom from appreciable deformation must be considered. Comparisons are also given between maximum allowable stresses and the stress-strain relations determined in the customary short-time tension tests at various temperatures.

(*Continued on p.* 20)

NOTES AND REVIEWS

Continued

The Influence of the Time Factor on Tensile Tests at Elevated Temperatures. By John S. Brown. Published in *Engineering* (London), Oct. 9, 1925, p. 461.

Do service demands for tensile strength in metals exceed those of the laboratory test sufficiently to invalidate the latter? If so, to what factor is the discrepancy due? In the author's opinion the difference is serious enough to be a distinct reflection on laboratory testing-procedure and is due to the restricted time in which laboratory tests are carried out. Two obstacles have seriously interfered with the giving of the proper allowance to the time factor; one is the difficulty of securing a human watcher for long periods, the other the desire not to tie up a testing-plant for too extended an interval. The author tells how these obstacles were overcome by an automatically recording instrument and the following procedure.

The specimen is subjected to selected service of stress and temperature for a period not less than a day. If failure does not occur, the period is extended somewhat, and if failure still does not occur, the conditions are made more severe. In all cases the rate of application of the load is less than 1 ton per sq. in. per day. Tests are described for high-tensile brass, phosphor bronze, monel metal, aluminum, and admiralty gunmetal. Among the conclusions reached is that the practical value of all the records from tests of the ½-hr. type have evidently been brought under suspicion, and that to date no expedient has been found which would reduce further than has been done in the procedure outlined above, the time required to carry through a test while still ensuring that the prominent time effect does not vitiate the result.

Application of the Mathematics of Probability to Experimental Data as a Basis for Appropriate Choice of Ferrous Materials. By B. D. Saklatwalla and H. T. Chandler. Published by American Society for Steel Treating, Cleveland. 12 pp.

The number of alloy-steels that are now in use makes the problem of selecting the most suitable alloy-steel a perplexing one. In this paper the authors suggest a method of reasoning which should be of practical value on solving this problem. The "law of error" and "the law of frequency" are considered.

Probability curves are given in which the Brinell hardnesses are plotted against the frequency number of castings in foundry practice. This graphic method of representation gives more satisfactory results than mere averages of numbers.

Automobile Body Plant Lighting. By James M. Ketch, H. J. Thompson and E. F. Labadie. Published in *American Machinist*, Oct. 15, 1925, p. 617.

Five conditions that make unique the problem of lighting automobile-body plants are listed: the movement of bodies on a continuously moving conveyor; the dark and vertical exterior surfaces; the difficulty of seeing inside the bodies for trimming and upholstery; the requirements of especially good lighting for expensive materials or high-speed cutters used in upholstery; and the care required in inspecting outer surfaces. Descriptions are given of the different lighting-systems required for the interior of the dry kiln, the assembly-room and the metal, spraying, trimming and upholstery departments.

Recent Developments in Bus-Body Design. Published in *Autobody*, October, 1925, p. 143.

Lowering the center of gravity and providing protection for the passengers on the upper deck are said to be the most

(*Continued on p.* 22)

Above, the fleet of the Wagner Baking Co., Detroit, Mich. Fafnir Ball Bearings used for replacements.

Single row radial, the standard bearing for automotive service.

Double row radial, for carrying additional radial load without enlarging the bearing diameter.

Single row radial thrust, for radial load as well as end thrust.

Double row radial thrust, carries both heavy radial and thrust loads.

Thrust bearing.

Below, the trucks of the United Fuel and Supply Co., Detroit, Mich. Fafnirs used for replacenemts.

Truck builders prefer Fafnir— let their experience guide you in bearing replacements

Builders of trucks know ball bearings. They have again and again compared, tested and even abused them to see what particular make of bearing can always be relied on to give service in keeping with the high quality of their trucks.

And the fact that so many of the leading manufacturers are using Fafnirs is a most convincing reason why it will pay you, also, to standardize on Fafnirs for replacements. Only in this way can you be sure of the dependable transportation which the truck maker intended you should have.

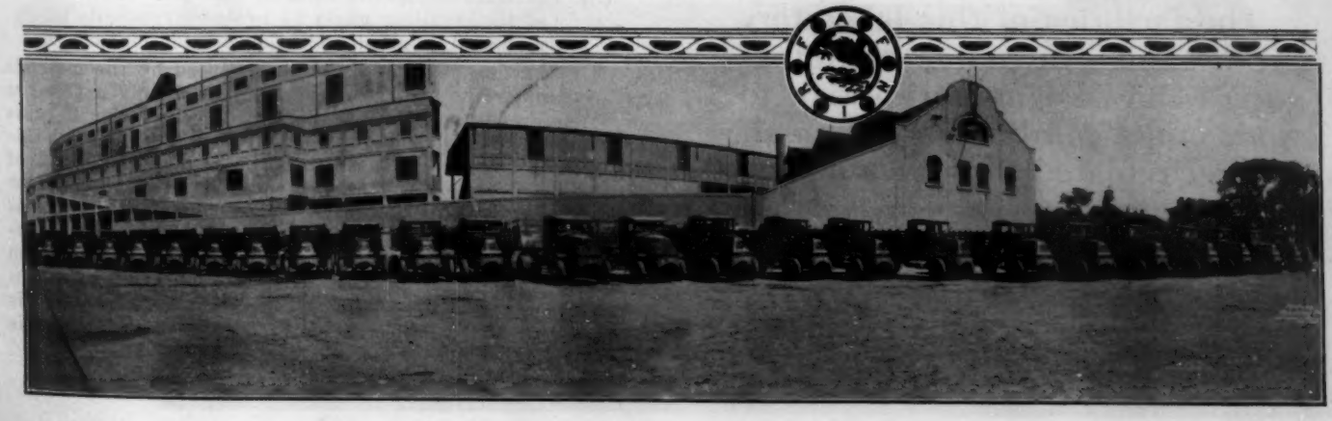
Furthermore, you can obtain Fafnir bearings without delay. Fafnir distributors are accessibly located in all parts of the country. They carry a complete stock of replacements — a bearing for your every replacement need.

THE FAFNIR BEARING CO.

Makers of high grade ball bearings — the most complete line of types and sizes in America

NEW BRITAIN, CONN.
CHICAGO NEWARK
CLEVELAND DETROIT

FAFNIR
BALL BEARINGS



NOTES AND REVIEWS

Continued

notable developments in the design of double-deck motorcoaches. In summarizing the trend toward luxury in vehicles used on long-distance routes, the introduction of observation platforms and buffet parlor-cars are particularly stressed. Conformity of the windshield with the general appearance of the vehicle and better disposition of baggage are two of the objects sought in city-type motorcoaches where the improvement has been in details rather than in any radical features. A knock-down body for export is also referred to. Finally the effects on body design likely to be felt from such chassis developments as gasoline-electric drives, airbrakes and six-wheel designs are described.

Road Shocks. Published in *The Automobile Engineer*, October, 1925, p. 329.

In this article are discussed the fundamental principles affecting the interaction of road springs and shock-absorbers. A brief review of the mathematical calculations relating to the vibration of a loaded spring, in which the case of a single wheel and its load is considered, starts the article. The action of three different springs, one fairly stiff, another nine times as flexible and a third midway between the two is described. From the calculations developed, the conclusion is drawn that when the inequalities of a road-surface are short and close together, the springs of a vehicle should be relatively flexible; conversely, when the inequalities are long, stiff springs are the most suitable.

In introducing the subject of compound springs, the author says that to a large extent the improvement effected by a supplementary spring merely indicates that the original spring was faulty, for the two springs, acting together, have precisely the same effect as a single simple spring of intermediate natural frequency. The function of tires as springs is considered of no importance. Two types of shock-absorber, one consisting essentially of a hydraulic brake and the other of a mechanical brake, are appraised. The caution is voiced that the springing should never interfere with the important duty of maintaining frictional contact between the wheels and the road. Finally a description is given of a hydraulic rebound-snubber, the principle of which has not, to the author's knowledge, been utilized.

Complete Utilization of Coal and Motor Fuel. By A. C. Fieldner and R. L. Brown. Published in *Oil, Paint and Drug Reporter*, Oct. 5, 1925, p. xii.

Deprecating the possibility of reinforcing our petroleum resources either by oil shale or by alcohol from vegetation, the authors state that coal is the logical source of liquid-fuel substitutes for petroleum gasoline. Three processes for obtaining motor fuel from coal are listed:

(1) The carbonization of coal, including the gas manufacturing and coking industry, and low-temperature carbonization
(2) The hydrogenation of coal by the Bergius process
(3) The complete gasification of coal and conversion of the resulting gases by pressure synthesis into methanol, synthol and other liquid combustibles

After showing that the gasoline produced by the methods outlined under the first heading would meet only a fraction of our petroleum needs, the author describes the Bergius process. Several estimates as to the probable yield from this process are made, one that from 1 ton of coal 50 gal. of 230-deg. cent. (446-deg. fahr.) end-point gasoline could be obtained. The production of motor fuel by direct synthesis from gases is said to be more economical. Methanol, for instance, is manufactured from carbon monoxide and hydrogen at a cost varying from 18 to 27 cents per gal. The manufacture of other motor fuels, such as synthol, from gases is referred to and the probable course of future development is outlined.

(*Continued on p. 24*)

NOTES AND REVIEWS

Continued

Wearing Qualities of Tire Treads as Influenced by Reclaimed Rubber. By W. L. Holt and P. L. Wormeley. Bureau of Standards Technologic Paper No. 294. Published by Bureau of Standards, City of Washington. 6 pp.

Service tests were made on 80 "sectional tread" tires to determine the comparative resistance to wear of tread compounds containing reclaimed rubber and those compounded using new rubber only. The tread of each tire was made in four sections, each section representing a compound under test. The results of tread wear as obtained from each individual tire are shown, and, for comparison, data on laboratory wear-tests of the same rubber compounds are also given. These results show that the substitution of reclaimed rubber for new rubber in these compounds reduces the resistance of the compounds to wear roughly in proportion to the amount of reclaimed rubber used.

Special Libraries Directory. Compiled by May Wilson. Published by Special Libraries Association, New York City. 254 pp.

Assembled in the Special Libraries Directory is the information collected by the Special Libraries Association in a 12 months' survey that was completed about July, 1924. Only libraries in this Country created for a particular purpose were covered, to the exclusion of general, public, college and school collections. The directory lists 975 libraries, classified in four ways, according to subject, geographical location, alphabetically according to name, and according to the names of the chief librarian. A complete subject index is also provided. The full description of any library may be found if only the subject, the geographic location or the name of the library or the name of the librarian is known.

Of the libraries listed, 25 are said to afford special facilities for the study of automobiles and automotive engineering; 21, for aviation; and 11, for petroleum.

Aircraft Year Book for 1925. Published by Aeronautical Chamber of Commerce of America, New York City. 316 pp.; 87 illustrations.

What did America accomplish in aviation in the year 1924? The seventh annual edition of the Aircraft Yearbook tells us that in all notable performances of the year, the United States maintained undisputed leadership; 32 new world records were won by America; a constructive Congressional inquiry was carried out, and the manufacturers representing the aircraft industry met and drafted policies for its guidance.

No single factor is believed to have had so much influence in commercial aviation as the establishing of the Air Mail Service; this volume presents some most interesting facts concerning the inner workings of this important branch of the government service.

Undoubtedly aerial surveying occupies the most promising place in commercial aviation at present, both in gross business and in the number of airplanes utilized as well as in the number of men employed. The growth of aerial surveys is attributed to a real demand that has been carefully cultivated from the start. In the first 2 or 3 years, the principal use made of aerial photographs was as illustrations for newspapers and magazines. Some were used for display advertising purposes and some even adopted by the large industrial plants of the Country in place of the imaginative and so-called "bird's-eye views." Translating air photos into maps to be used in tax reappraisals is an interesting phase of aerial surveying. Greater New York was mapped from the air and forests were surveyed by aerial photographs.

Other commercial operations such as saving crops, forest air patrol and airplanes in mining are treated in this book. Some of the remaining chapters are as follows: The Round-the-World Flight, America's Airships, World Aeronautics,

(*Continued on p. 26*)

NOTES AND REVIEWS
Continued

Chronology and Technical Progress. The latter part of the book contains the Aircraft and Engine-Design Section and an appendix is attached that includes many facts and figures of value to those interested in aeronautics.

Recent Progress in Flying-Boat Design. By O. E. Simmonds. Published in *Engineering* (London), Oct. 2, 1925, p. 429.

Recent progress in flying-boat design, in the opinion of the author, has been due to the growing attention paid to its marine functions. In connection with hull design, four points are outlined as of primary importance; static trim, hump resistance, steady running and cleanliness. The development in hull construction is traced from the beginning, when hulls were built like superstructures; through the intermediate stage, when flexible wooden hulls were favored; to the present when these are being displaced by light metal bodies. The relative advantages of duralumin and steel for this purpose are outlined.

In connection with airfoil characteristics, the selection of the suitable section and the reduction of the movement of the center of pressure are discussed. Constructional features tending to reduce the parasitic drag, the equipment of the flying-boat and future developments in this type of craft are the final topics.

The New Handley Page W9 Hampstead. Published in *Flight*, Oct. 1, 1925, p. 625.

Comparing the new Handley Page W9 with its forerunner, the W8f, the author finds in the latter a higher reserve and total power and a greater wing-span. The increase in the wing-span is shown to be due entirely to the lengthening of the center section to enable the three propeller-discs to operate clear of one another. Three Armstrong-Siddeley Jaguar engines constitute the powerplant, and changes due to the fitting of these engines are the only differences, aside from those already noted, between the two Handley Page models.

The Hampstead is built to carry 14 passengers and 700 lb. of luggage, bringing the total paying load up to 3220 lb., or less than 3 lb. per hp. The question as to whether this comparatively large power expenditure in proportion to load will prove profitable commercially is taken up.

The estimated maximum speed of the airplane is 117 m.p.h., the estimated service ceiling is 12,000 ft., and the estimated rate of climb at ground level is 720 ft. per min.

Condensation of Water from Engine Exhaust for Airship Ballasting. By Robert F. Kohr. Bureau of Standards Technologic Paper No. 293. Published by the Bureau of Standards, City of Washington. 26 pp., 20 illustrations.

This paper describes a method of condensing a large part of the water-vapor formed during combustion in an airship engine by the combination of the oxygen of the air with the hydrogen of the fuel. The condensation is accomplished by cooling the exhaust-gas in a bank of thin-walled tubes suspended in the air stream. Some of the condensed water remains in the form of spray and is collected by passing the cooled gas through a baffle-type separator. The quantity of water present in the exhaust-gas is influenced by the kind of fuel, ratio of air to fuel in the mixture supplied the engine and the humidity of the entering air. The effect of these variables is presented in the form of tables and curves.

The performance of the apparatus during both ground and flying tests is summarized and suggestions made regarding possible improvements. The heat-transfer process involved in the air-cooled condenser used is described in detail, and a sample design is carried through to illustrate the method of determining the necessary length of the condensing apparatus.

(*Concluded on p. 28*)

TRUCK AND BUS TO HAVE NEW POWER BRAKE

Demonstrated at Motor Registry, It Proves to Be a "Quick Stopper"

Trucks, busses and other heavy types of motor vehicles will shortly be equipped with power brakes as a result of satisfactory tests made before registry officials at Commonwealth Pier.

The particular type tested is called the "vacuum booster." It is operated by the foot pedal in much the same manner as now, but the pressure required is so slight that the test car was stopped by merely pressing the pedal with one finger.

Pressure on the pedal opens a valve that creates a vacuum on one side of a piston attached to the brake rod and the pressure on the other side pushes the piston through this vacuum, driving the brake rod back with tremendous force.

Inspector Alfred W. Devine of the registry, in discussing the new brake, which it is believed will play an important part in reducing accidents, stated the average truck operator can apply only 150 pounds on the present foot brake, as a maximum. It is next to impossible he said, to bring enough pressure on a ten or twelve-ton truck with the foot to keep the brake drum from sliding within the brakes. In the test made of the new power brake on a truck weighing more than seven tons without load, the truck was stopped almost instantly while going at a rate of ten miles an hour and within thirty-three feet going twenty miles.

The regulations require that brakes be effective within forty-five feet going twenty miles an hour.

From Boston American, Nov. 14th, 1925.

MAY FORCE TRUCKS TO USE POWER BRAKES

Boston, Nov. 17 (U. T. P. S.).—Power brakes for trucks and busses will be compulsory in this state if Registrar of Motor Vehicles Frank A. Goodwin's advice is taken by the incoming legislature. The registrar claims that only such brakes can properly stop heavy motor vehicles.

Recently a test of a new power brake was made on a 7-ton truck, unloaded. It stopped within 33 feet at 20 miles an hour, and almost instantly while traveling but ten. The brake tried in demonstration was shown to be easily handled. It is applied by the foot, but the demonstrating operator showed that the pressure of the finger on the foot pedal was sufficient to work the brake.

From Automotive Daily News, Nov. 18th, 1925.

NOTES AND REVIEWS

Concluded

A New Type of Flying Machine. Published in *Flight*, Oct. 22, 1925, p. 683.

This novel type of airplane is known as the de la Cierva Autogiro. It is furnished with a four-blade propeller, mounted on an approximately vertical shaft and having its blades pivoted around horizontal axes on this shaft. This windmill, as it is called, is not geared to the engine, but is caused to rotate slowly by the air-forces acting upon it. Centrifugal force is relied upon to keep the blades outstretched against the action of the lift, and by slightly arching the blades the designer has attempted to ensure all stresses being purely tensile. Aside from the windmill propellers, the plane has an Avro 504K fuselage with normal tail, a le Rhone rotary engine, and an Avro undercarriage.

The over-all span is 36 ft.; the mean chord of the wings is 2 ft. 7 in. and the area of each wing is 40 sq. ft. At full speed the windmill lifting surfaces revolve at 140 r.p.m., which indicates a tip speed of 260 ft. per sec. or 180 m.p.h., from which the airplane obtains its lift. The Autogiro is capable of flying horizontally under perfect control; it can, if desired, glide down at about the normal angle for an ordinary machine, or descend at an extremely low horizontal velocity.

Standard Atmosphere Tables and Data. By Walter S. Diehl. National Advisory Committee for Aeronautics. Report No. 218. Published by National Advisory Committee for Aeronautics, City of Washington. 14 pp.

This report is an extension of National Advisory Committee for Aeronautics Report No. 147. Detailed tables of pressures and densities are given for altitudes up to 20,000 m. and to 65,000 ft. In addition to the tables the various data pertaining to the standard atmosphere have been compiled in convenient form for ready reference.

The Flettner Rotor Ship in the Light of the Kutta-Joukowski Theory and of Experimental Results. By Frank Rizzo. National Advisory Committee for Aeronautics Technical Note No. 228. Published by National Advisory Committee for Aeronautics, City of Washington. 28 pp.; 6 illustrations.

In this paper the fundamental principles of the Flettner rotor ship are discussed in the light of the Kutta-Joukowski theory and available experimental information on the subject.

A brief exposition of the Kutta-Joukowski theory is given and the speed of the rotor ship Buckau computed, first by using effective propulsive force obtained by the above theory, and then by the direct application of wind-tunnel data.

The calculation shows that, although a certain relation exists between theoretical and experimental speeds, those obtained by wind-tunnel data are undoubtedly closer to the actual speeds of the ship than are those obtained by the use of the theoretical propulsive force.

Wind Tunnel Tests of Fuselages and Windshields. By Edward P. Warner. National Advisory Committee for Aeronautics Technical Note No. 226. Published by National Advisory Committee for Aeronautics, City of Washington. 6 pp.

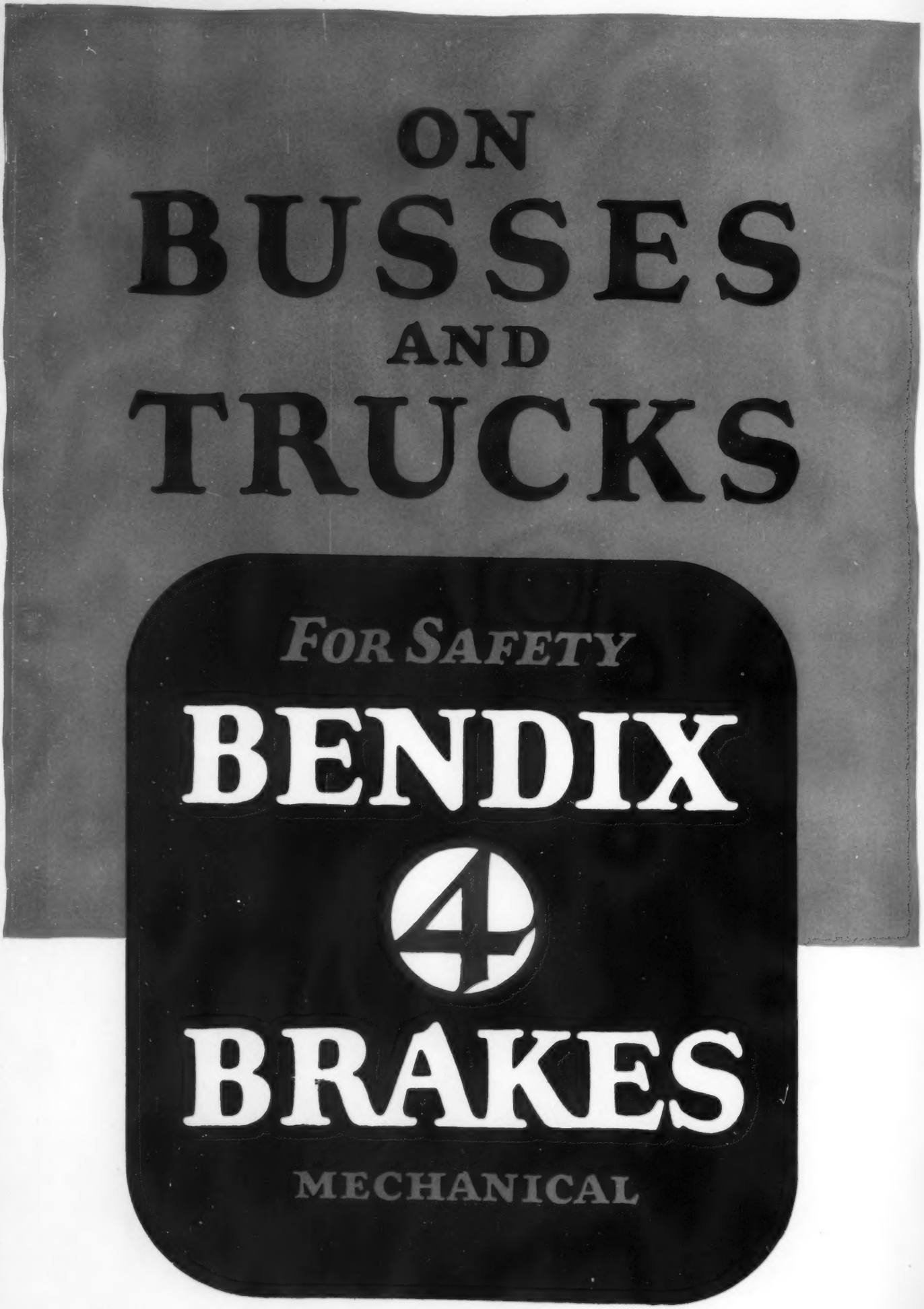
The primary object of the tests was to secure data on the effect of windshield form on the total resistance of a fuselage of a good streamline shape. Secondarily, information was sought on the degree of protection afforded the pilot by the windshield. Five windshields were tried, and a final experiment was made with no windshield at all. The windshield extending over the full width of the fuselage and breaking upward from the smooth surface at a fairly sharp angle was found to offer the least resistance. With the shortest, narrowest and steepest of the five shields the resistance was greatest. The difference between the best and the worst was so small, according to the note, that the effect of the windshield on performance may be safely ignored.

Bendix Brakes hold this truck and can certainly stop your car

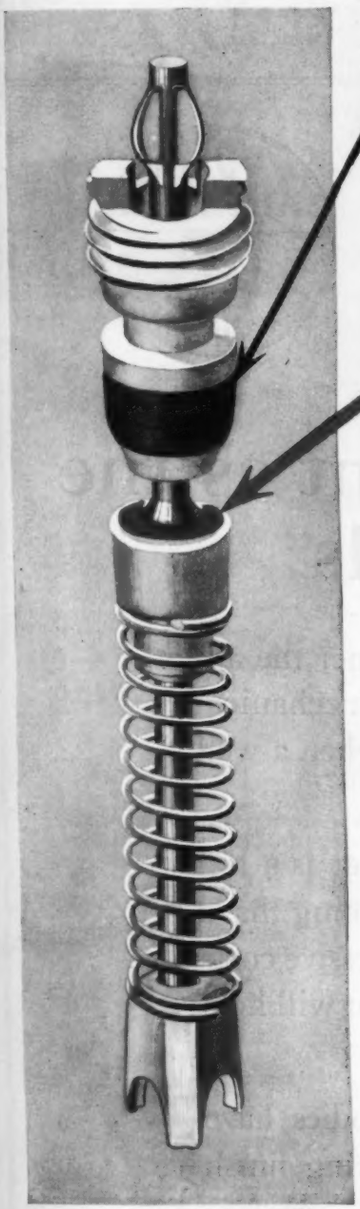
FOR SAFETY

BENDIX 4 BRAKES

MECHANICAL


ON
BUSSES
AND
TRUCKS
FOR SAFETY
BENDIX
4
BRAKES
MECHANICAL

What you should know about the Schrader Valve Inside



The Schrader Valve Inside Magnified 4½ times.

Many people think this black plug washer is the only part of the Schrader Valve Inside that controls the air—but it is not.

A Schrader Valve Inside, if screwed down tight, never leaks at this point.

This red rubber washer is the vital part of the Schrader Valve Inside—the actual air control seat. It is here that the valve inside opens to admit air and closes to retain it.

IF a valve leaks, remove the valve inside and examine the red rubber seat washer. If it is dirty, remove the dirt with a small, clean brush. (Do not use gasoline or oil.) You will then find that in most cases the valve will be air-tight.

If it is not air-tight after cleaning, the reason may be due to one or more of the following conditions:

(a) The valve inside may have been damaged during inflation by an improperly constructed air-chuck. (The Schrader Chuck cannot injure the valve inside.)

(b) Oil or "muck" from an air-line may have caused the red rubber seat washer to rot. Oil is an enemy of rubber.

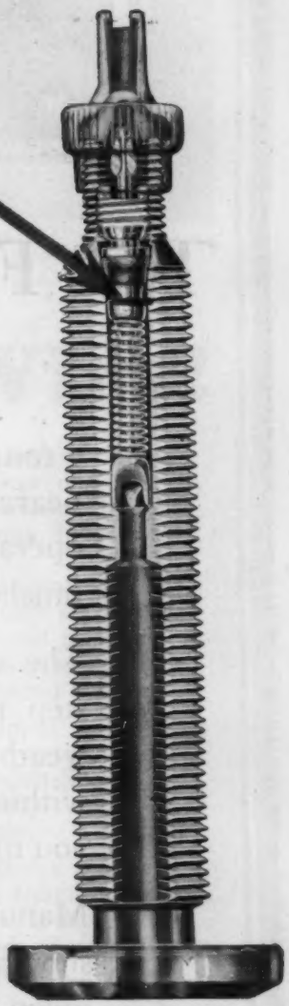
(c) The valve inside may have given its full length of service.

In such cases, the valve inside should be replaced with a new one. Wonderful as it is, it will not last forever.

Schrader Valve Insides cost so little that motorists can well afford to insure continued satisfactory service by renewing them at least once a year.

A. SCHRADER'S SON, Inc., Brooklyn

Chicago Toronto London

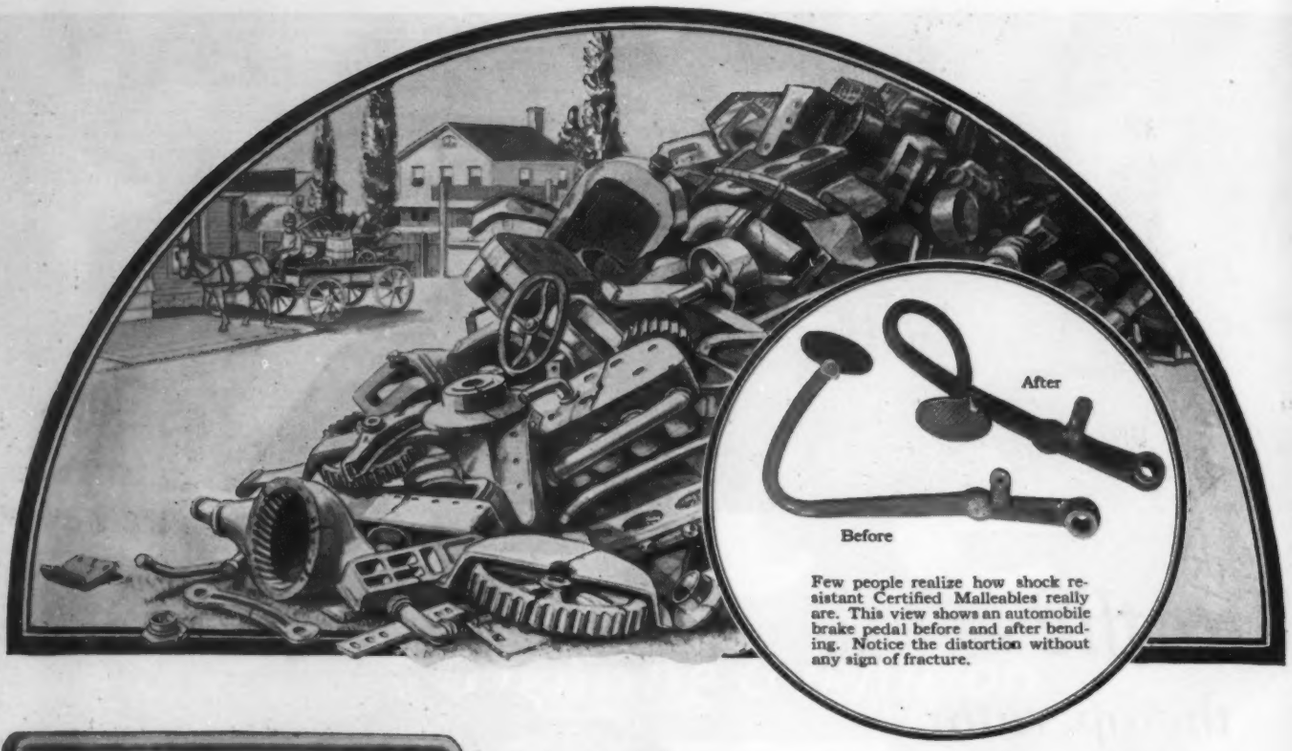


This "X-Ray" picture shows the Schrader Valve Inside inserted in the Schrader Tire Valve.

Schrader

Makers of Pneumatic Valves Since 1844

Tire Valves · Tire Gauges



Few people realize how shock resistant Certified Malleables really are. This view shows an automobile brake pedal before and after bending. Notice the distortion without any sign of fracture.

Certificate Holders for the Quarter Ending Sept. 30, 1925

Albany Malleable Iron Co. ..... Voorheesville, N. Y.
Albion Malleable Iron Co. ..... Albion, Mich.
American Chain Co. ..... Bridgeport, Conn.
American Malleable Castings Co. ..... Marion, O.
American Malleables Co. ..... Lancaster, N. Y. and Owosso, Mich.
Badger Malleable & Mfg. Co. ..... South Milwaukee, Wis.
Baltimore Malleable Iron & Steel Casting Co. ..... Baltimore, Md.
Belle City Malleable Iron Co. ..... Racine, Wis.
Chain Belt Co. ..... Milwaukee, Wis.
Chicago Malleable Castings Co. ..... West Pullman, Chicago, Ill.
Columbia Malleable Castings Co. ..... Columbia, Pa.
Columbus Malleable Iron Co., The ..... Columbus, O.
Danville Malleable Iron Co. ..... Danville, Ill.
Dayton Malleable Iron Co. ..... Dayton, O., Ironton, O., and Canton, O.
Decatur Malleable Iron Co. ..... Decatur, Ill.
Devlin Mfg. Co., Thomas ..... Philadelphia, Pa.
Eastern Malleable Iron Co., The ..... Naugatuck Malleable Iron Works, Naugatuck, Conn.; Bridgeport Malleable Iron Works, Bridgeport, Conn.; Troy Malleable Iron Works, Troy, N. Y.; Wilmington Malleable Iron Works, Wilmington, Del.; Vulcan Iron Works, New Britain, Conn.
Erie Malleable Iron Co. ..... Erie, Pa.
Federal Malleable Co. ..... West Allis, Wis.
Fort Pitt Malleable Iron Co. ..... Pittsburgh, Pa.
Fraser & Jones Co. ..... Syracuse, N. Y.
General Electric Co. ..... Erie, Pa.
Glancy Malleable Corporation ..... Waukesha, Wis.
Illinois Malleable Iron Co. ..... Chicago, Ill.
Iowa Malleable Iron Co. ..... Fairfield, Ia.
Kalamazoo Malleable Iron Co. ..... Kalamazoo, Mich.
Laconia Car Co. ..... Laconia, N. H.
Lakeside Malleable Castings Co. ..... Racine, Wis.
Link-Belt Co. ..... Indianapolis, Ind.
Marion Malleable Iron Works ..... Marion, Ind.
Moline Malleable Iron Co. ..... St. Charles, Ill.
National Malleable & Steel Castings Co., Cleveland, O., Chicago, Ill., Indianapolis, Ind., Toledo, O., E. St. Louis, Ill.
Northern Malleable Iron Co. ..... St. Paul, Minn.
Northwestern Malleable Iron Co. ..... Milwaukee, Wis.
Peoria Malleable Castings Co. ..... Peoria, Ill.
Pittsburgh Malleable Iron Co. ..... Pittsburgh, Pa.
Rhode Island Malleable Iron Works ..... Hillsgrove, R. I.
Rockford Malleable Iron Works ..... Rockford, Ill.
Ross-Meehan Foundries, The ..... Chattanooga, Tenn.
St. Louis Malleable Casting Co. ..... St. Louis, Mo.
Saginaw Malleable Iron Co. ..... Saginaw, Mich.
Standard Malleable Castings Co. ..... Terre Haute, Ind.
Stowell Co., The ..... South Milwaukee, Wis.
Superior Steel Castings Co. ..... Benton Harbor, Mich.
Symington Co., The ..... Rochester, N. Y.
Temple Malleable Iron & Steel Co. ..... Temple, Pa.
Terre Haute Malleable & Mfg. Co. ..... Terre Haute, Ind.
Trenton Malleable Iron Co., The ..... Trenton, N. J.
Union Malleable Iron Co., The ..... E. Moline, Ill.
Vermilion Malleable Iron Co. ..... Hoopeston, Ill.
Wagner Malleable Castings Co. ..... Hammond, Ind., and Beloit, Wis.
Warren Tool & Forge Co. ..... Warren, O.
Webster Mfg. Co., The ..... Chicago, Ill.
Wisconsin Malleable Iron Co. ..... Milwaukee, Wis.
York Mfg. Co. ..... York, Pa.
Zanesville Malleable Co. ..... Zanesville, O.

Reduce the Nation's Scrap Pile By Using Certified Malleable Iron

EVERY piece of metal in this scrap pile could tell a story of breakage, disappointment and expensive delay. Disrupted train schedules, costly wrecks, expensive harvest delays, dangerous breakdowns of trucks and motor cars, and failures of vital parts in all classes of machinery represent an annual waste of time and money that runs into many millions of dollars.

Most of this waste could be prevented by the more liberal use of Certified Malleable Iron which is strong enough and durable enough to resist breakage and insure absolute safety.

Certified Malleable Iron will stand more shock and abuse without breakage than any other ferrous material. Therefore, it should be used wherever parts must withstand shock and vibration, where breakage must be eliminated and where time saving is essential.

Certified Malleable Iron is the product of those plants who receive a quarterly certificate of merit from the consulting engineer of the American Malleable Castings Association; certifying that their product has met his exacting physical tests and that their plant practice, as shown by rigid inspection, insures the production of uniform malleables of the highest quality and integrity.

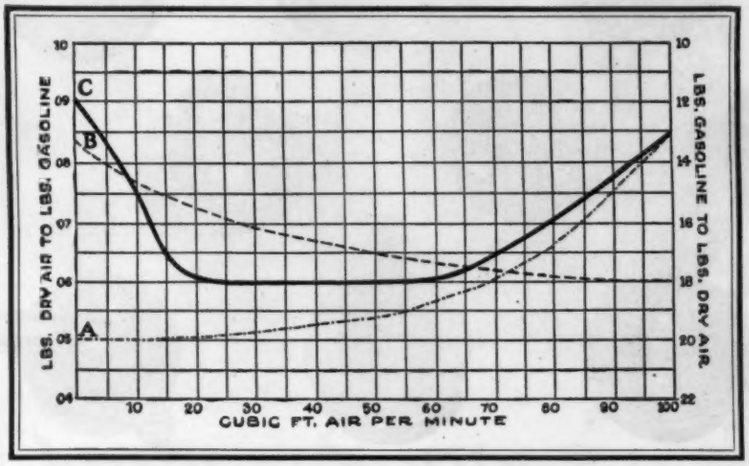
AMERICAN MALLEABLE CASTINGS ASSOCIATION
UNION TRUST BUILDING CLEVELAND, OHIO

POSITIVE PHYSICAL PROPERTIES AcA CERTIFIED TRADE MARK

CERTIFIED-MALLEABLE CASTINGS

Only the RAYFIELD *combines these advantages*

Showing clearly why the Rayfield is most efficient and economical at all speeds. Curve "A" represents action of typical "plain tube" carburetor—too lean a mixture for idling and at low speed. Curve "B" typical "expanding type" carburetor—too lean a mixture at high speed. Curve "C" the New Rayfield —a richer mixture when needed and the most economical at all other times.

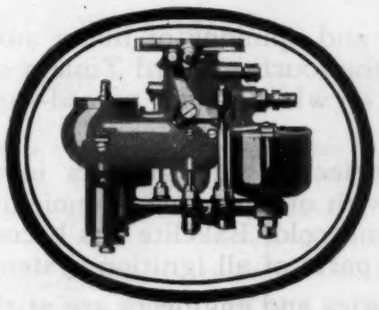


PLAIN tube *versus* expanding type! For years automotive experts have championed the relative merits of these two schools of carburetor design.

Yet unbiased engineers have long observed the shortcomings of each. "Plain tube" carburetors, of ample capacity, provide too lean a mixture for idling and low speeds, "expanding type" carburetors, too lean a mixture at high speeds. With neither is perfect engine performance at all speeds possible.

Now comes Rayfield with a new and better carburetor, combining *the advantages only of both the plain tube and expanding type of carburetors.*

At low speeds the New Rayfield is an expanding type carburetor, assuring reliable idling and smooth low-speed performance. At high speeds it is a plain tube carburetor supplying the richer mixture needed for greater power. And in addition, positive means are provided for quick starting, reliable idling and rapid acceleration.



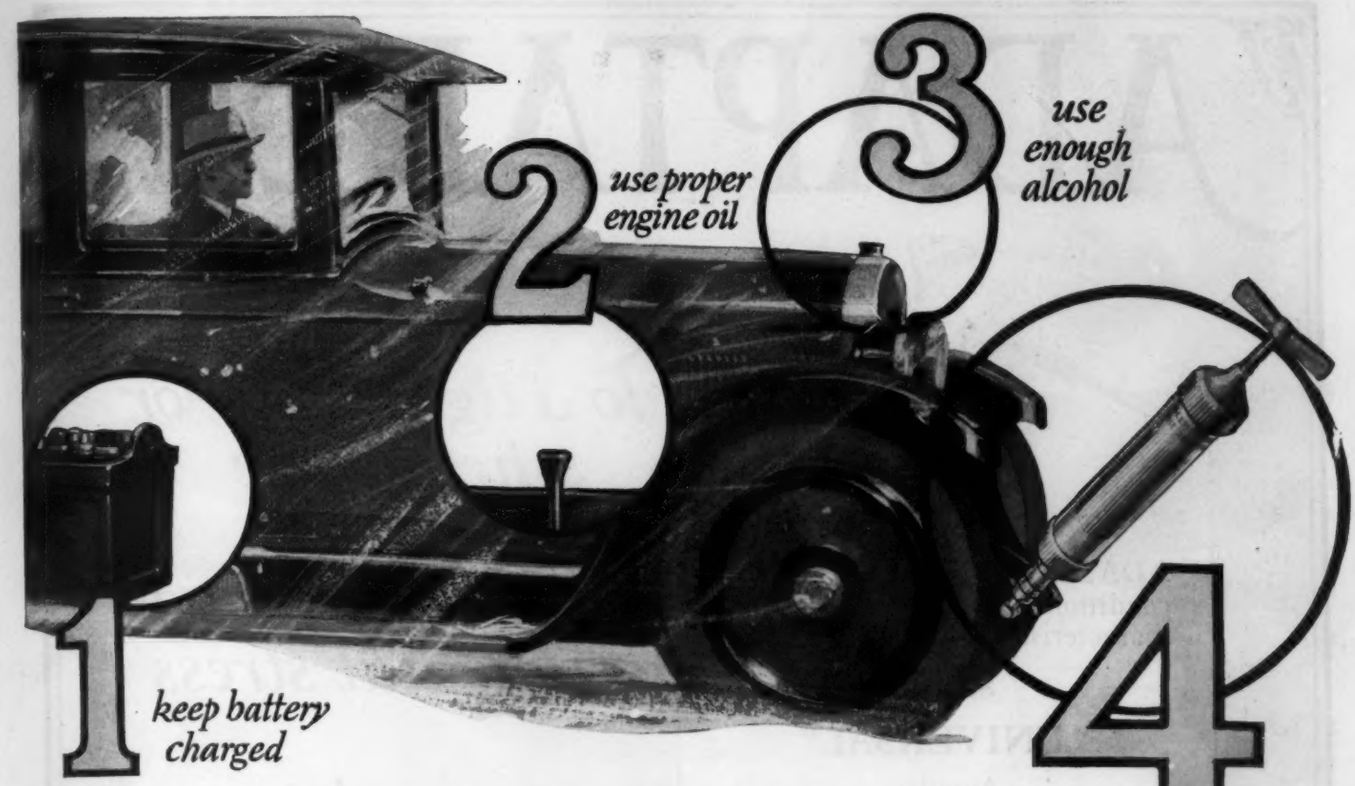
Yet this New Rayfield is simple. And its price is low—lower than other carburetors which cannot begin to equal its wonderful performance.

A careful test of this carburetor on several of your own cars will be more convincing than paragraphs of copy.

Write today to Beneke Manufacturing Co., 21st and Rockwell Streets, Chicago.

The New

RAYFIELD CARBURETOR



The 4 Danger Spots in Winter

for chassis bearings
ALEMITE
cold proof lubricant

How safe are your cars in the hands of the average motorist?

IF BATTERIES run down, or radiator freezes, or motor oil becomes too thick to function, the average motorist realizes that the fault is his. But chassis bearings are different.

He cannot *see directly* the effect of cold weather on his chassis bearings. He may attempt to lubricate them with warm weather oils or greases. He doesn't know the difference. Furthermore, he won't take the trouble in cold weather to see whether every bearing is receiving the right amount of lubrication.

And in the Spring, when repair bills start, he'll blame them on the car. He never blames himself. Over half the complaints that car dealers receive are due to this one cause—lack of proper lubrication.

Alemite and Alemite-Zerk lubricating systems are just as sure in Winter as in Summer. Positive high pressure does the job right under all conditions. And convenient Alemite Lubricating Service stations make lubrication "Every 500 miles" a year round habit. Furthermore Alemite Chassis lubricant at 30 degrees below zero has the same lubricating efficiency as average cup grease at 70 degrees above zero.

If your cars are Alemite, or Alemite-Zerk equipped, they will stand the cold weather test.

THE BASSICK MANUFACTURING CO.
2654 North Crawford Ave.
CHICAGO · ILLINOIS
Canadian factory: Alemite Products Co. of Canada, Ltd., Belleville, Ont.

ALEMITE

Products of
The BASSICK MANUFACTURING COMPANY

ALEMITE-ZERK

Service for cars with either system at any Alemite Station.

ALEMITE

High Pressure Lubrication

Wherever It Must Be the Best

Driving his Packard Chriscraft II with a Delco-equipped Packard marine motor, Col. J. G. Vincent won the Detroit Sweepstakes, breaking every displacement speed boat record up to 150 miles.

From start to finish Col. Vincent drove a wonderfully consistent race, never dropping below a speed of 50 miles an hour.

Such certain, dependable, never-failing performance is typical of Delco-equipped power plants whether on the road, over the water or in the air.

The leading automotive experts of the country turn invariably to Delco for the best in electrical equipment.

THE DAYTON ENGINEERING LABORATORIES CO.
DAYTON, OHIO, U. S. A.

Delco
STARTING LIGHTING IGNITION

NORTHEASTER

$7.50

THE Northeaster is a real Magnetic Horn that marks a sweeping advance in horn construction. It is the last word in simplicity and scientific design.

It has a strong, clear note. It is full of punch and persistence without disagreeableness. It has a sure and instant response. *And* it is built throughout with characteristic North East ruggedness and long life.

Here is a Horn that is bound to win immediate favor regardless of price. Add to this the unbelievably low figure at which it is offered, and there is no limit to the demand that will be created for the Northeaster.

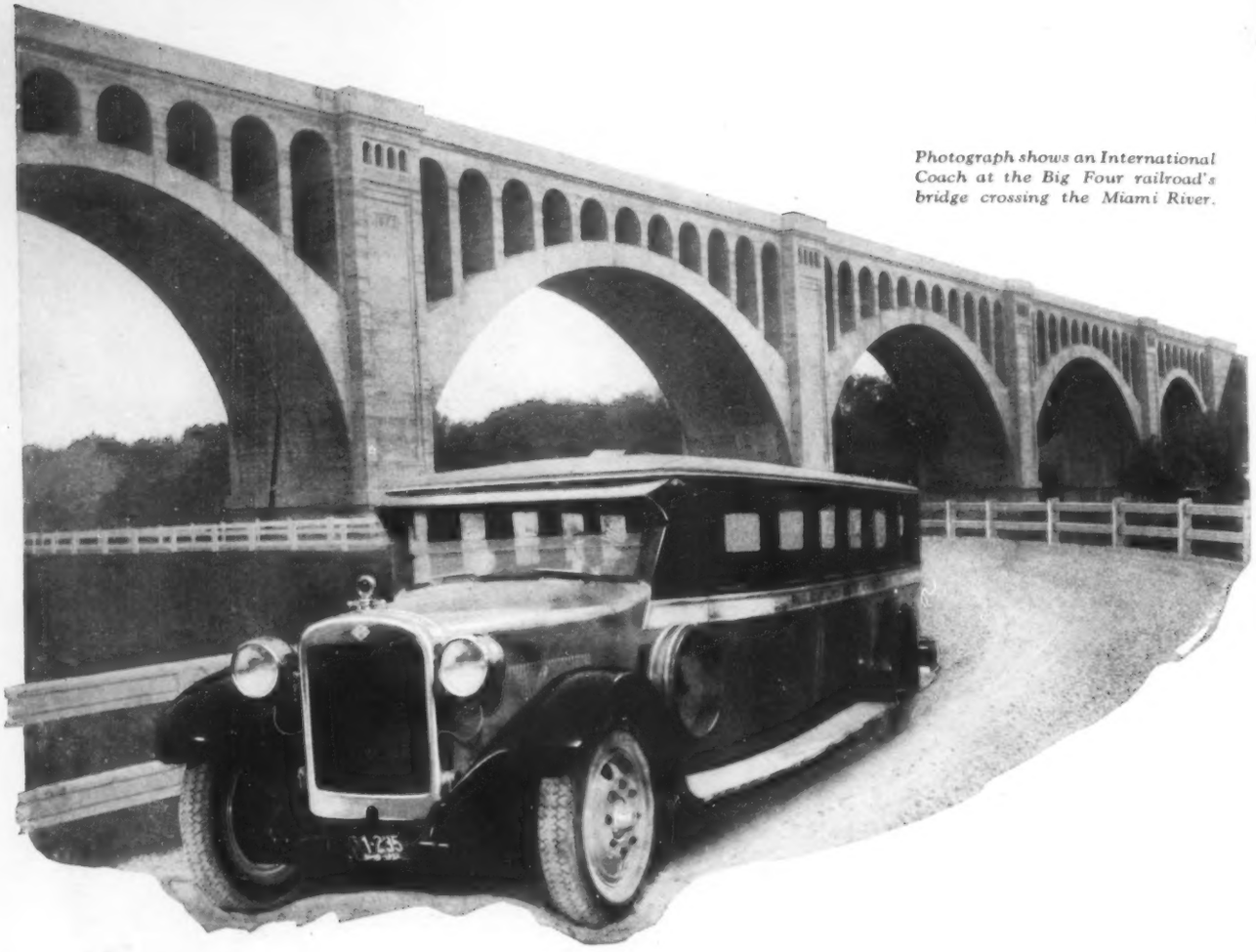
Now is the time. Get in at the start. Full details from any North East Service Station or Branch.

A Real Magnetic Horn at a *Low* Price

NORTH EAST ELECTRIC CO. *The Standard for Dependability and Long Life.* NORTH EAST SERVICE INC.

Starting, Generating & Ignition Equipment - Horns - Speedometers

ROCHESTER · ATLANTA · CHICAGO · DETROIT · NEW YORK · KANSAS CITY · SAN FRANCISCO · PARIS · LONDON · TORONTO



Photograph shows an International Coach at the Big Four railroad's bridge crossing the Miami River.

LONG PRODUCTS

AUTOMOTIVE CLUTCHES

and

RADIATORS

The high speed and long hauls required for bus service demand much from the cooling systems.

Long Radiators are performing satisfactorily on International Coaches.

LONG

THE LONG MANUFACTURING CO., DETROIT, MICHIGAN

There is a greater resale value to the car that is equipped with CELORON SILENT GEARS

A USED car is as good as its engine. Therein lies the true basis of valuation.

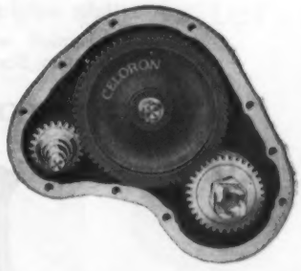
If the motor runs smoothly and quietly, the resale of the car is much easier without profit-killing price reductions.

The engine with Celoron Silent Gears runs quietly for life and, by very reason of this smooth operation, maintains its timing accuracy, its gas and oil economy and its flexibility.

An increasing number of car manufacturers use Celoron Silent Gears to give greater initial worth and greater resale value.

Dealer and owner alike are benefited and the car maker is amassing an immediate good-will asset with an added future cumulative value.

We shall be glad to furnish sample gears to any responsible person on request.



A Celoron Silent Gear properly mated with metal gears will stop front end noises. The resiliency of Celoron cushions the shocks of clashing teeth and keeps timing true and accurate for the life of the car. Operating economy is sustained in the Celoron equipped car.

DIAMOND STATE FIBRE CO.

Bridgeport, Pa., and Chicago, Ill.
Paris, France London, England
Diamond State Fibre Co. of Canada, Ltd.
Toronto, Canada

Makers of
DIAMOND FIBRE and CELORON

Cigar Lighters
Windshield Cleaners
Parking Lights
Tire Carriers

or—Automobiles?

Some motor car manufacturers seem to feel that success in the automobile business is a matter of selling accessories—with an automobile thrown in. They apparently have lost sight of the fact that a dozen added accessories can't balance a dozen words spoken by some friend of a prospective buyer.

"A Tourabout sedan? Don't be foolish! Ask Dick Williams what happened to the body of his, last summer."

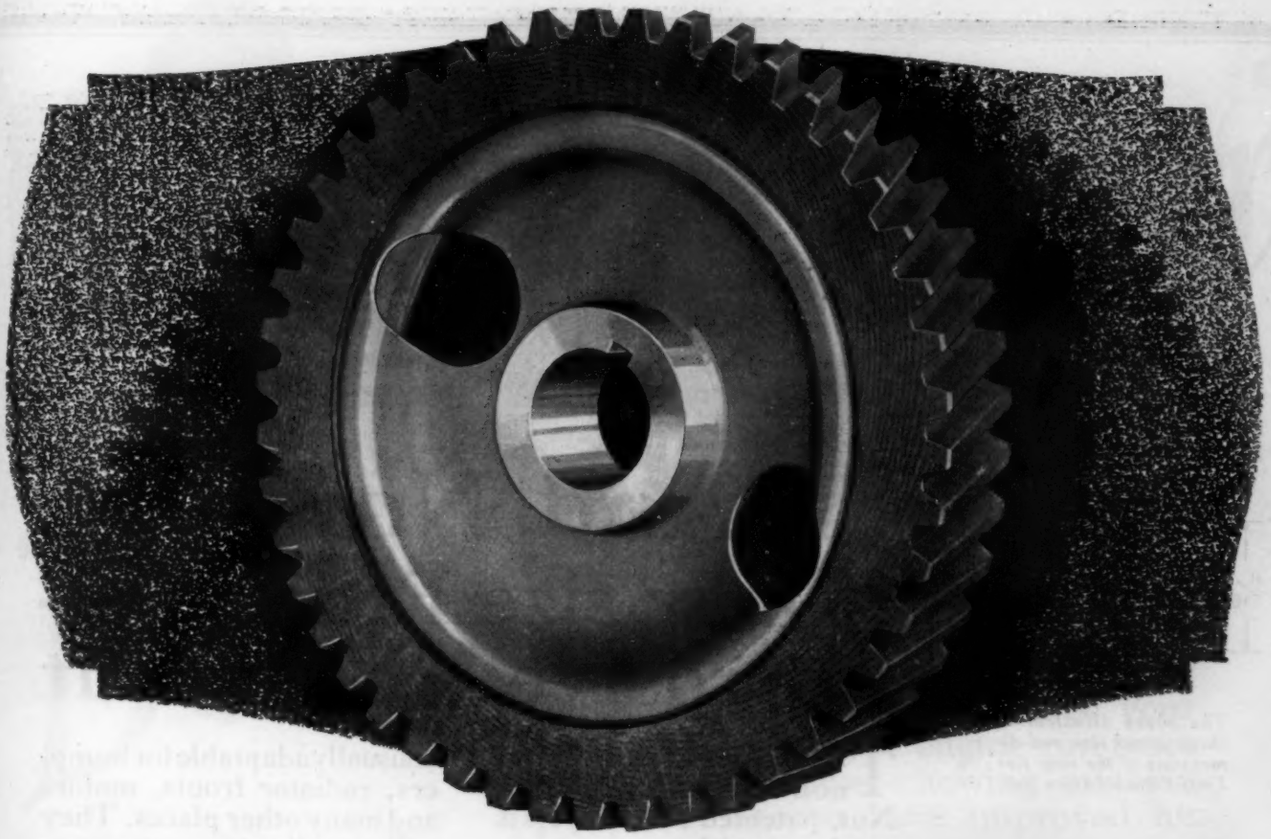
Another sale lost—lost to some rival manufacturer who stuck consistently to making and selling sound value in *automobiles*.

Where Sales are Made

—in clubs, offices, homes and wherever else owners meet and compare experiences—the reputation of the Raulang-equipped closed car is safe.

Raulang Body Division · THE BAKER R & L COMPANY · *Cleveland, Ohio, U. S. A.*

Raulang TRADE MARK AUTOMOBILE BODIES



A Remarkable NEW Timing Gear *developed by* Formica

THIS new timing gear is so elastic that it eliminates the effect of backlash and absorbs the vibration of the running shafts. It provides the most silent and lasting timing drive. It has shown in repeated tests an ability to stand three and a halt times the torque a full molded fabric gear will stand.

The gears can be cut with great rapidity by modern production methods, and the tooth surfaces are absolutely smooth.

The gear consists of a specially molded ring of Formica and a pressed steel center. The two are joined mechanically by a shrink-press fit which takes care of any difference in the expansion of the two materials at different temperatures.

The gear is light and has little fly-wheel effect on the camshaft. The Formica ring is so built up that all wear on the teeth comes on the fibre ends, a construction that assures longer wear, less noise, and a retention of surface lubrication.

In hundreds of thousands of miles of test running, the gear gave perfect results, and has given equally perfect service on thousands of cars since it actually went into production.

Tool expense for its production is high but it offers a thoroughly satisfactory and durable timing and accessory drive for the volume manufacturer who can buy in quantity. The novel features of the gear are all covered by patent applications.

Let Formica engineers provide you with all the facts about this most important development.

THE FORMICA INSULATION COMPANY
4648 Spring Grove Avenue, Cincinnati, Ohio

FORMICA
Made from Anhydrous Bakelite Resins
SHEETS TUBES RODS

Be a noise killer

IT is a sure way to please all of your trade. If you make the engine run more quietly, even the least-knowing motorist appreciates that you have improved his car.

You know that the clash of metal-on-metal in the timing assembly is responsible for much of the irritating motor noise. You can put an end to this noise by installing a

Textolite
Silent Cam Shaft Timing Gear

Textolite Cam Shaft Timing Gears have a flexible web. They are die-formed. They will absorb the shocks of 100,000 miles of severest service. They are oil-proof, heat-proof and tougher than cast iron.

Textolite Gears are sold to the service trade through:

JOHN C. HOOF & COMPANY
157 West Illinois Street, Chicago, Ill.

Like many other General Electric products, Textolite Gears were developed in the Research Laboratories. Here scientists are working continually that men may have better materials with which to work.

50-29

GENERAL ELECTRIC

GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y., SALES OFFICES IN ALL PRINCIPAL CITIES

Now the Feminine Touch Steers Balloons

You foretold the feminine influence in motoring. You encouraged it, welcomed it—it's here.

Just how comfortable has driving been made for the ladies? Enthusiasm aside for the moment, the balloon tire *is* rather brutal on them. Parking, steering in traffic, the quick curves—really balloons are not as much fun to the feminine driver as they should be.

Why not?

To Hannum the answer lay in the steering gear. The old gears do not meet the new conditions. They rely on sheer muscular energy to perform the laborious work of *lifting* the car. The steering gear should do most of that work itself.

The Hannum Steering Gear *does* it. And only the Hannum principle *can* do it.

That's why it is creating such intense interest throughout the automotive world. The Hannum Steering Gear fulfills the promise of the balloon tire. It ends a real source of motor fatigue. It is truly a welcoming gesture to femininity.

Women will *buy* the Hannum-equipped car.

HANNUM MANUFACTURING CO., MILWAUKEE, WISCONSIN

HANNUM

As the steering nut moves to extreme end of screw its trunnion block slides out further along the jaws, thereby increasing the leverage that operates the pitman arm. This decreases steering effort at extreme travel. When steering nut is at center, torque arm is shorter, giving more sensitive control of road movement through lessened movement of steering wheel.

Motorists—particularly women motorists—have become *steering-conscious.* Balloon tires have made them so. Parking now classes as a feat of strength. Steering through traffic is an ordeal that taxes the strong and the brave. It was high time for a steering gear such as Hannum to correct the defects of steering control. Now the balloon tire is mastered. The Hannum Steering Gear is a notable advance in comfortable driving control.

STEERING

IT is with a distinct sense of pride that we announce Hayes Wheels as standard equipment on the Locomobile Junior Eight. This selection is, we feel, a signal tribute to Hayes traditions. It is evidence of the valued advantages which the Hayes Wheels alone possess.

It is reassuring to know how completely Hayes Wheels justify the judgment of the manufacturer in his selection and gratify the desire of the motorist by enabling him to have the most modern wheel equipment on his car.

Offering, as do Hayes Wheels with Attached-Lug Rims, time saving in tire changes and tire saving by remaining always in true alignment; freedom from loose lug annoyance; elimination of rim squeaks, it is perfectly reasonable to expect an increasing high tide of approval.

HAYES WHEEL COMPANY, *Manufacturers*, Jackson, Michigan, U.S.A.

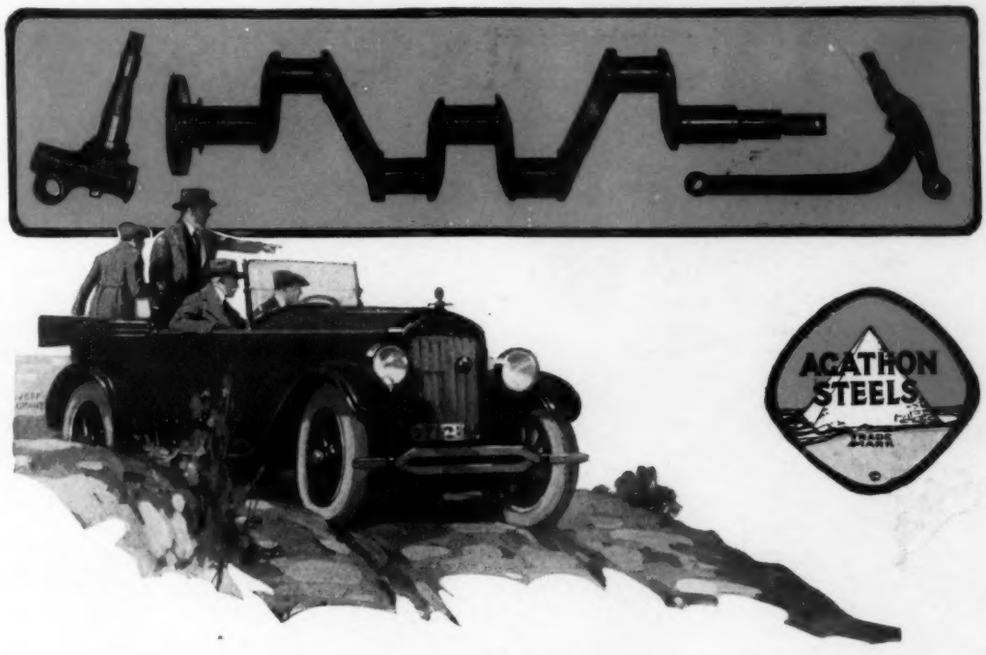
Factories: Jackson, Mich.; Albion, Mich.; Anderson, Ind.; Nashville, Tenn. Canadian Plants: Chatham and Merriton, Ont.

Export Office: 30 Water Street, New York City.

HAYES WHEELS

WITH ATTACHED LUG RIMS—STANDARDIZED IN WOOD, WIRE AND DISC

What's in a Name?



For Highly Stressed Automobile Parts

UMA No. 2 is a steel which can be made to yield any particular strength between 95,000 pounds per square inch and 200,000 pounds per square inch, by merely varying the drawing temperature.

There is scarcely a part of any appliance or machine whose properties do not lie within these limits. This flexibility makes it possible for a manufacturer to restrict his stock to the single UMA No. 2 steel instead of carrying a number of special grades to meet the same ends.

It is possible to heat treat, then finish machine with Brinell Hardness as high as 332, with the maximum combination of strength and ductility.

UMA No. 2 is particularly suitable for production forging, and is being used successfully for front and rear axles, steering knuckles and arms, crank and drive shafts, connecting rods, valve stems, spring clips, highly stressed shafting and machine parts subject to heavy shock.

Send for our Agathon Alloy Steel handbook giving details and charts covering our entire UMA series—made *only* by us.

We also have daily production in all kinds of Agathon Alloy Steels such as—

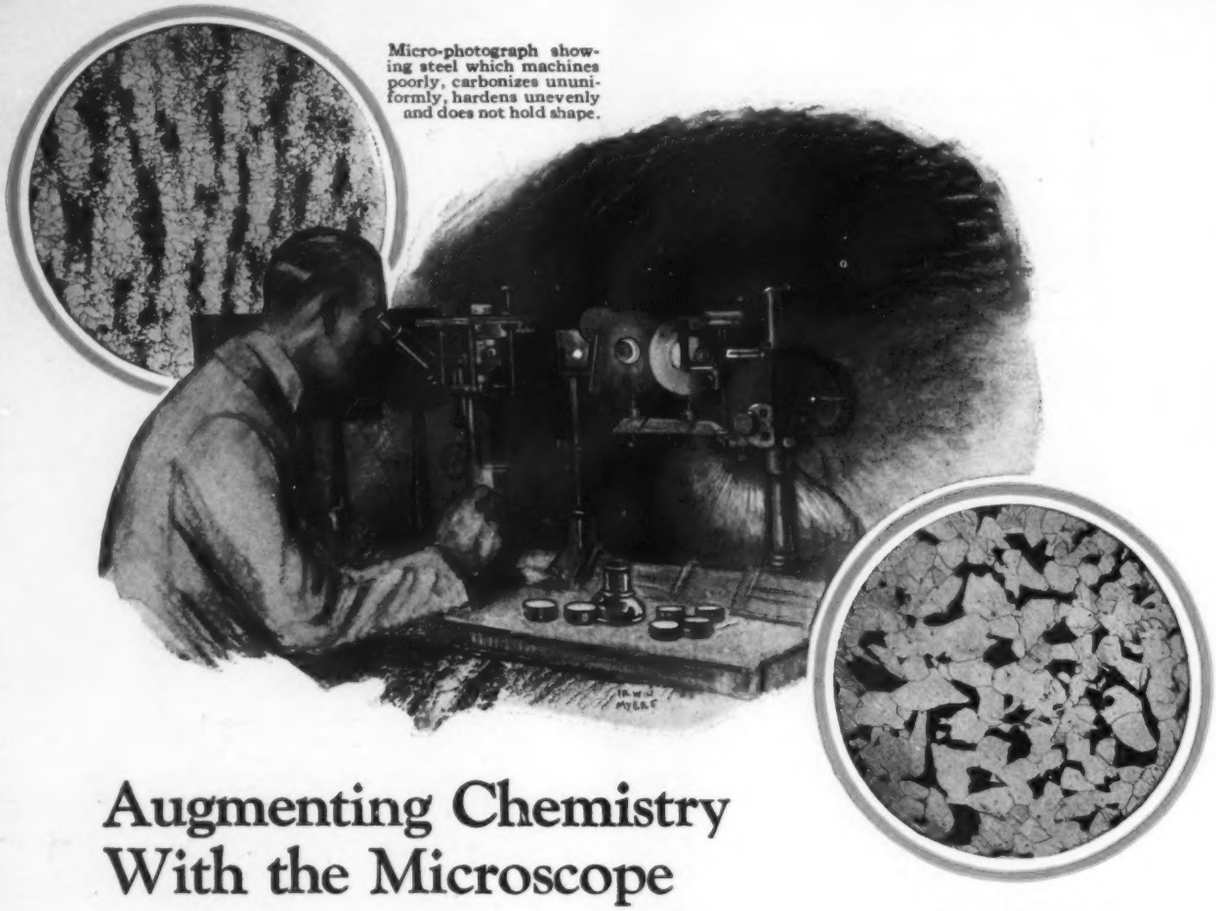
Nickel, Chrome-Nickel, Molybdenum, Chrome-Molybdenum, Nickel-Molybdenum, Vanadium, Chrome-Vanadium, Chromium, etc.

Deliveries in Blooms, Billets, Slabs, Hot Rolled, Heat Treated, and Cold Drawn Bars, Hot Rolled Strips, etc.

THE CENTRAL STEEL COMPANY, Massillon, Ohio

Swetland Bldg., Cleveland — Book Bldg., Detroit — Peoples Gas Bldg., Chicago
Aeolian Bldg., New York — University Block, Syracuse — Widener Bldg., Philadelphia
303 W. P. Story Bldg., Los Angeles, California

UMA-No2 ALLOY STEEL



Micro-photograph showing steel which machines poorly, carbonizes ununiformly, hardens unevenly and does not hold shape.

Augmenting Chemistry With the Microscope

Micro-photograph of steel that machines well, carbonizes uniformly and hardens deeply without distortion.

WHILE strict adherence to formulae and painstaking care in chemical analysis has long characterized Agathon Alloy Steels, adoption of the microscope in checking various heats now enables us to provide you alloy steels of such uniform texture that savings of thousands of dollars are often made in machining operations alone.

When furnishing steel, we also send preliminary test pieces from which, with the aid of a microscope, the machining and heat treating qualities can be predicted with a great degree of accuracy. If you have a problem in steel, why not let our skilled metallurgists help you solve it? There is no charge. Ask for booklet "Agathon Alloy Steels."

We have daily production in all kinds of Agathon Alloy Steels such as—

Nickel, Chrome-Nickel, UMA, Molybdenum, Chrome-Molybdenum, Nickel-Molybdenum, Vanadium, Chrome-Vanadium, Chromium, etc.

Deliveries in Blooms, Billets, Slabs, Bars, Spring Flats, Hot Rolled Strips, etc.

THE CENTRAL STEEL COMPANY, Massillon, Ohio

Swetland Bldg., Cleveland — Book Bldg., Detroit — Peoples Gas Bldg., Chicago
Aeolian Bldg., New York — University Block, Syracuse — Widener Bldg., Philadelphia
303 W. P. Story Bldg., Los Angeles, California

AGATHON ALLOY STEELS

Waukesha Motored Metro-Goldwyn Transcontinental Trackless Train

SELLING the MOVIES with a WAUKESHA MOTOR

Here is an outstanding example of motor performance; a Waukesha engined Trackless Train pulling a 16000 pound Trailer, hauling a total load of 24000 pounds, and standing up to a rigid schedule through all kinds of weather and roads. Performance of this rugged character is what sells buses and trucks. Hence, the results of this severe test will be most interesting to progressive bus and truck builders who require maximum power, economy, and service life.

Waukesha "Ricardo Head" Bus and Truck Motors are built in both 4 and 6-cylinder types in sizes from 15 to 100 H. P. Write for "Dynamic Thermostat Book" describing latest Waukesha feature.

WAUKESHA MOTOR COMPANY

Waukesha, Wisconsin

Eastern Sales Office Aeolian Building, 33 W. 42nd Street New York City

Better light means a better truck—an easier truck to sell

THAT is the big reason why so many of America's leading manufacturers of trucks are equipping them with dependable, economical, efficient Prest-O-Lite Gas.

Prest-O-Lite equipment makes night hauling safe, speedy and profitable.

Prest-O-Lite Gas is easy and economical to install and can be relied upon to give perfect service throughout the life of the truck.

From the truck user's standpoint it gives perfect satisfaction. Its mellow, penetrating light is dependable under all road and weather conditions.

Legal everywhere.

In short, as the Cleveland Coca-Cola Company wrote us recently, "Prest-O-Lite Gas is the most economical and satisfactory lighting system for commercial vehicle work."

Thirty-six big gas-producing plants serve thousands of Prest-O-Lite Stations all over the country. Truck users can always get a full tank for an empty one by paying a small amount for the gas only.

As manufacturers of storage batteries for lighting trucks, as well as Prest-O-Lite Gas, we are in a position to tell you the lighting equipment that has proved most satisfactory in various types of service.

THE PREST-O-LITE CO., INC.
INDIANAPOLIS, IND.
New York San Francisco
In Canada: Prest-O-Lite Company of Canada, Ltd., Toronto, Ont.

Prest-O-Lite Gas

THE BEST LIGHT FOR ALL HEAVY-DUTY TRUCKS

Braking a Milk Bottle on Wheels

The most modern method of transporting milk from the country to the city is by means of "milk bottles on wheels," sanitary glass-lined tank cars and trucks—a method now used by a number of Dairy Companies.

To avoid spilling as well as spoiling the milk, to insure safe as well as sanitary transportation, these tank trucks are equipped with Westinghouse Automotive Air Brakes.

Adequate control of such heavy trucks is afforded by these brakes under all operating conditions—without tiresome effort on the part of the driver. And if trailers are hauled, they also are equipped with Air Brakes which are under the control of the driver, and will automatically apply if the trailer breaks away.

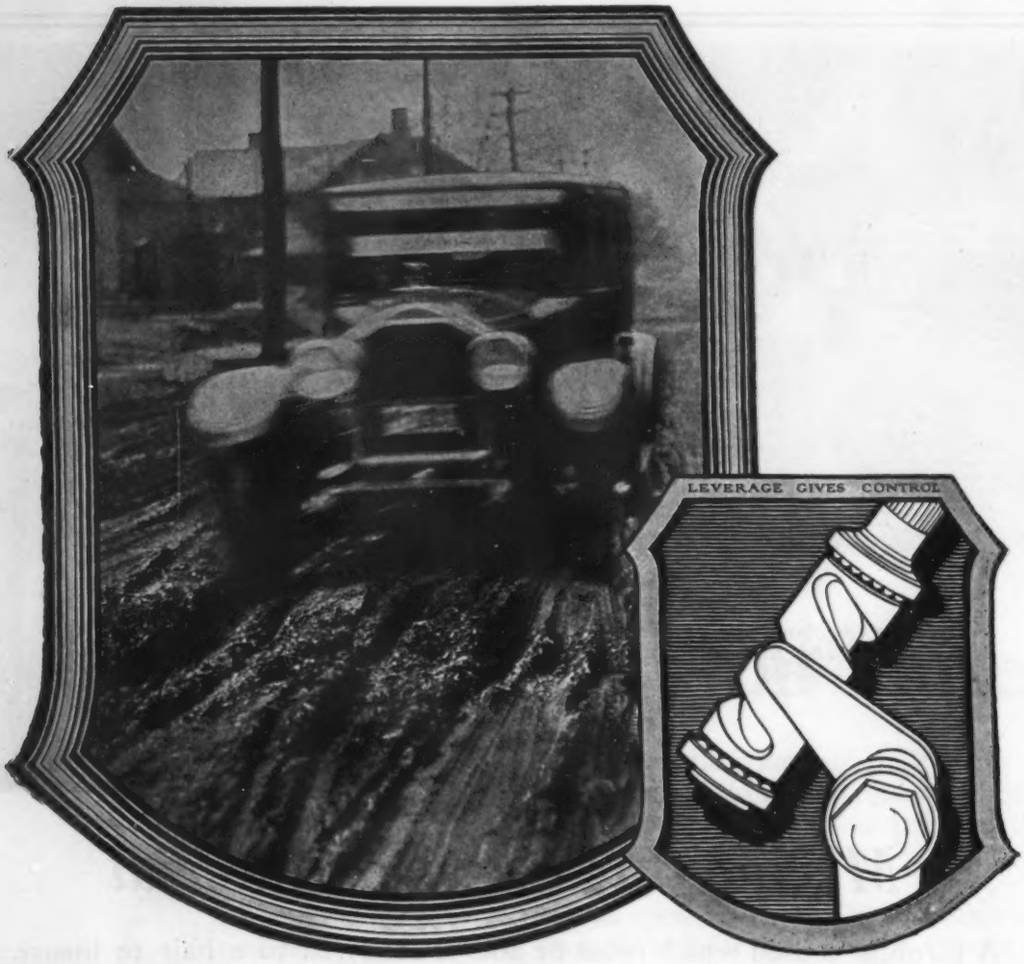
More than 2000 automotive vehicles, of all kinds, and operating under a great variety of conditions, are equipped with Westinghouse Air Brakes. Leading manufacturers are applying them as optional or standard factory equipment on buses, trucks, and trailers.

WESTINGHOUSE AIR BRAKE CO.

Automotive Division

General Offices and Works, WILMERDING, PA.

New York Washington Chicago St. Louis San Francisco Detroit



Taking Them *Easy!*

SLIP . . . slide . . . bump . . . jolt, in the deep frozen ruts that buffet the car from side to side. Unpleasant driving, at best! But not so wearying, nor so hazardous, as it once was, for your Ross Cam and Lever Steering Gear *checks* the incessant shock from the road—takes the punishment *you'd* get otherwise. Emergencies like this emphasize the many advantages Ross gives all the time.

At the New York Show—Space C—41 Grand Central Palace

ROSS GEAR AND TOOL COMPANY, *730 Heath Street,* Lafayette, Indiana

ROSS

CAM *and* LEVER STEERING GEARS

EASIER STEERING LESS ROAD SHOCK

CRANK CASE DILUTION PREVENTED!

Result—

5000 Miles and More Without Changing Oil

Motor Life Doubled

Dilution stopped at the source

PRESENT day fuel gives only partial combustion. Unburned gasoline in alarming quantities passes down between the piston and cylinder wall and dilutes the crankcase oil, impairing its lubricating qualities. The oil film between piston and cylinder wall is broken down. Excessive wear results.

That is what happens in every automobile engine unless this unburned gasoline is intercepted at the source of dilution.

This is exactly what the Skinner Oil Rectifying System does, *and the Skinner System alone.* Both unburned gasoline and excess oil are intercepted and removed *from the lower piston ring groove* before harm can occur. (See description at right.) Gasoline cannot enter the engine oil—dilution is stopped at its source.

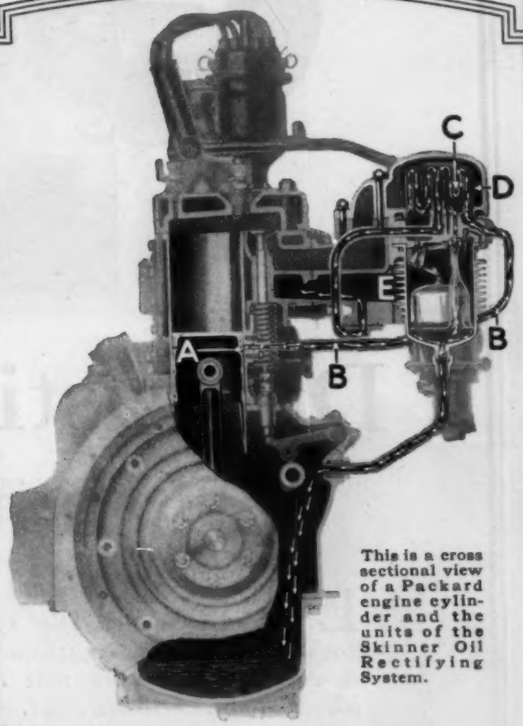
Moreover, another desirable feature of great importance especially to winter drivers is embodied in the Skinner System. Both water and sulphuric acid are prevented from accumulating in the crankcase. Thus, not only are the steel wearing parts protected against injurious corrosion, but the danger of the oil pump freezing is positively eliminated.

The results—5,000 miles and more without the necessity of changing oil—perfect motor lubrication maintained—all excessive wear eliminated—motor life doubled—upkeep costs reduced—performance improved.

Write for complete information or visit our exhibit, Space C 21, at the New York Automobile Show.

SKINNER AUTOMOTIVE DEVICE CO., INC.
1637 Lafayette Boulevard, West Detroit, Michigan, U. S. A.

SKINNER OIL RECTIFYING SYSTEM



This is a cross sectional view of a Packard engine cylinder and the units of the Skinner Oil Rectifying System.

How the Skinner System Operates

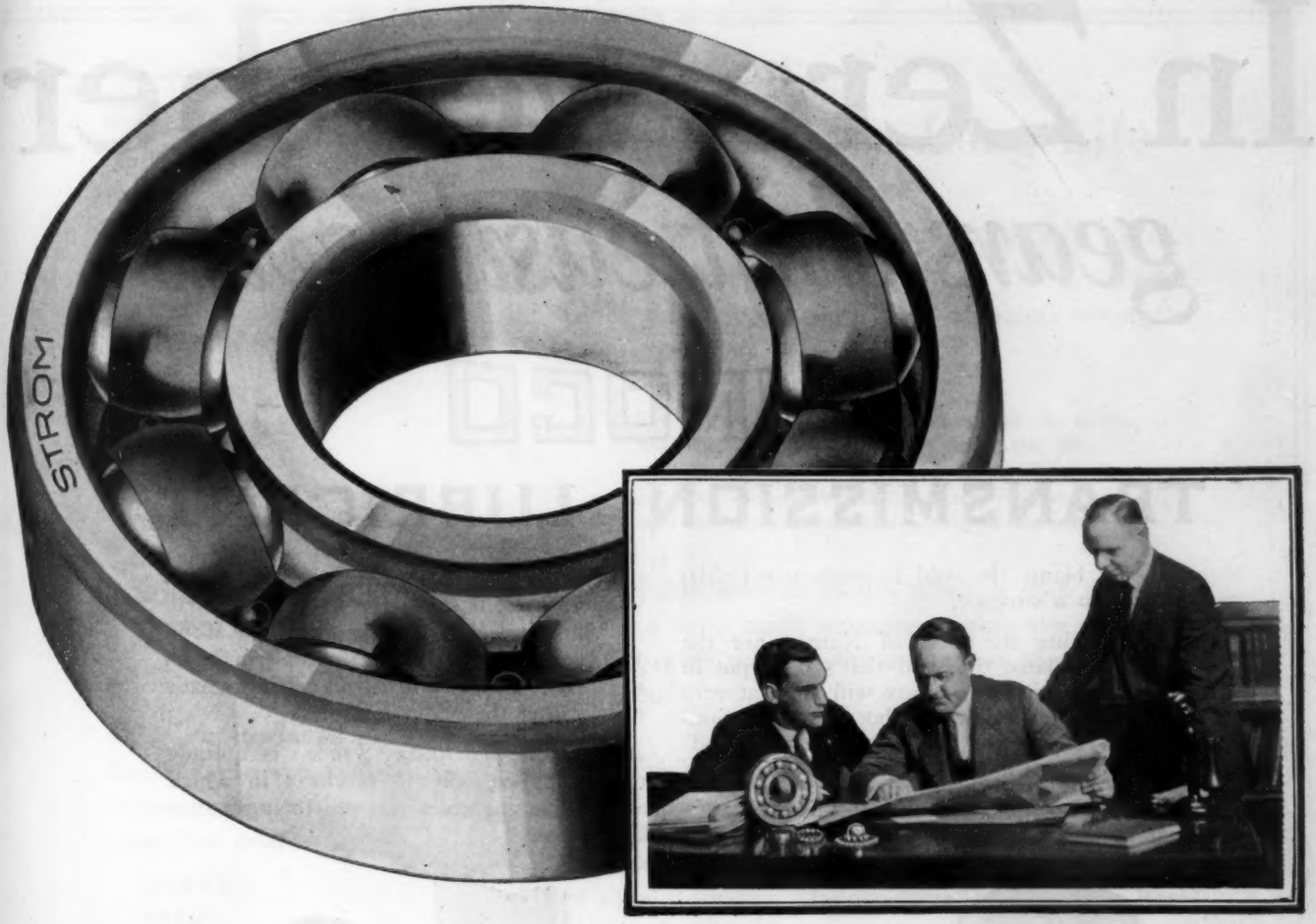
THE vacuum of the intake manifold intercepts and draws off unburned gasoline, water vapor and surplus oil from the lower piston ring groove (A) *before the unburned gasoline can pass into the crankcase.* Through pipe (B) this mixture of gasoline, water and oil is deposited in compartment (C), where it is heated by the engine exhaust (D).

The gasoline and water are vaporized and separated from the oil, and drawn into the engine through the passageway (E) in the form of combustible gas. The refined oil is collected in the lower compartment of the rectifier, and thence returned to the crankcase.

The Skinner Oil Rectifying System is *the only system* that actually prevents crankcase dilution. *The Skinner method of drawing off the unburned gasoline before it washes the oil film from the piston and cylinder wall is an exclusive feature.*

All new series Packard Sixes and Eights—more than 25,000 to date—have Packard's adaption of the Skinner Oil Rectifying System built into their engines. Packard dealers are also prepared to install the Skinner System in Packard cars in service. Packard states that the Skinner System is the greatest motor improvement since the perfection of the self-starter.

Ask any of the 25,000 new Packard owners!



Single-acting thrust bearing, flat seats (grooved races) 1100-F Series

Double-acting thrust bearing, flat seats (grooved races) 2100-F Series

Single-acting, self-aligning thrust bearing, leveling washer, 1100-U Series

Double-acting, self-aligning thrust bearing, leveling washers 2100-U Series

Super-Strom Ball Bearings

—for smoother operation, brilliant performance and much longer life

ENGINEERS of America's leading automobiles are specifying Strom Ball Bearings for use in all vital parts, particularly in transmissions, differentials and rear axles.

For Strom Ball Bearings have made good in service—proved their superiority in their much greater resistance to wear and the greater dependability they insure.

In transmissions, for instance, the new Super-Strom Ball Bearing gives positively continued smoothness of operation. It holds the shaft in permanently rigid alignment. Its accuracy and long-wearing qualities make for much longer life of the gears with much lower maintenance costs.

The new Super-Strom is a stock bearing — of the deep-grooved type, without filling slots. It offers increased load-carrying capacity by the use of larger balls. It is accurate to microscopic thousandths of an inch. Retainers are unusually sturdy. Balls are of chrome alloy steel and are held to limits of size and sphericity one-half that required. Rings are of special analysis steel, hardened throughout, not merely case-hardened, thus giving exceptional durability.

Now available in quantity production. Write for catalog, price list and technical data. Our engineers welcome inquiries. Get the facts.

Super-Strom deep groove, radial bearing

Double-row, deep-groove, radial bearing, bronze retainer

Angular contact bearing, combination radial and thrust

Adapter type bearing, with sleeve

Strom BALL BEARINGS

MARLIN-ROCKWELL CORPORATION
Successor to
STROM BALL BEARING MFG. CO., 4533 Palmer St., Chicago, Ill.

In Zero weather
gears shift easily with
SUNOCO
TRANSMISSION LUBRICANT

Don't blame the cold if gears won't shift without a struggle.

It's neither the fault of Nature, nor the gears. Blame the stuff that's been put in the transmission. Gears will shift at zero practically as easily as in hot weather if Sunoco Transmission Lubricant, the one product which is *made* for gear shifts, is used.

There's no sticky cylinder stock in it; there's nothing to get stiff in cold weather. It will not let the gears channel through it. At all temperatures, it keeps the gears lubricated. All Sunoco dealers have it or will get it; in fact, *any* dealer *can* get it if people insist on it. It often pays to insist on getting what's right rather than what's offered.

As perhaps you know, Sunoco is a trade name, applied only to products in which automotive engineers can put their greatest confidence.

Many lubricants for transmission and differential become so stiff in cold weather, they don't lubricate. The result is undue wear and noise.

Sunoco Transmission Lubricant, even at 20 below zero, will remain fluid and gears will shift easily.

SUN OIL COMPANY, Philadelphia

SUN OIL COMPANY, Limited, Montreal

Branches and Agents in Principal Cities—Dealers Everywhere

Why Pay for More Than You Get?

AN advertisement with this illustration appears over the Willard Battery men signature in The Saturday Evening Post and other leading magazines.

EVERY man of us subscribes to the policy of giving every car dealer, and every car owner, full value down to the last cent. That's why we sell Willard Charged bone dry Batteries. And we're on the job to see that everybody gets the same fair, square, courteous treatment.

The Willard Battery men

MEMBERS' PROFESSIONAL CARDS

INDEX TO ADVERTISERS' PRODUCTS

Marketed as Conforming With S.A.E. Standards and Recommended Practices, and Products for Which There Are No S.A.E. Standards

Absorbers, Shock
Stromberg Motor Devices Co.
Watson Co., John Warren

Acetylene
Prest-O-Lite Co., Inc.

Air Brakes (See Brakes, Air)

Air-Cleaners
Staynew Filter Corporation
Stromberg Motor Devices Co.

Air-Filters (See Air Cleaners)

Alloys, Alumino-Vanadium
Vanadium Corporation of America

Alloys, Cupro-Vanadium
Vanadium Corporation of America

Alloys, Ferro-Molybdenum
Vanadium Corporation of America

Alloys, Ferro-Tungsten
Vanadium Corporation of America

Alloys, Ferro-Vanadium
Vanadium Corporation of America

Alloys, Steel (See Steels)

Ammeters, B12
*Nagel Electric Co., W. G.
*Sterling Mfg. Co.

Apparatus, Acetylene-Generating
Oxweld Acetylene Co.

Apparatus, Cutting
Oxweld Acetylene Co.

Apparatus, Ignition**
*Bosch Magneto Co., Inc., Robert
*North East Electric Co.

Apparatus, Laboratory
Olsen Testing Machine Co., Tinius
Wilson-Maeulen Co., Inc.

Apparatus, Lead-Burning
Oxweld Acetylene Co.

Apparatus, Oxy-Acetylene
Oxweld Acetylene Co.

Apparatus, Welding
Oxweld Acetylene Co.

Appliances, Gas
Prest-O-Lite Co., Inc.

Aprons, Running-Board
Murray Mfg. Co., J. W.

Axles, Front, Motor-Truck
Wisconsin Parts Co.

Axles, Front, Passenger-Car
Salisbury Axle Co.

Axles, Motor Coach
Clark Equipment Co.
Wisconsin Parts Co.

Axles, Rear, Motor-Truck
Clark Equipment Co.
Wisconsin Parts Co.

Axles, Rear, Passenger-Car
Salisbury Axle Co.

Axles, Trailer
Salisbury Axle Co.

Babbitt, D103
*Federal-Mogul Corporation
General Die-Casting Co.

Balls, Brass, Bronze, Monel Metal, Aluminum
Hoover Steel Ball Co.

Balls, Hollow Bronze and Brass
Hoover Steel Ball Co.

Balls, Steel
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*Bethlehem Steel Co.
Grammes & Sons, Inc., L. F.

Bars, Boring
Williams & Co., J. H.

Bars, Bronze
Bunting Brass & Bronze Co.
Mueller Brass Co.

Bars, Pry
Danly Machine Specialties, Inc.

Batteries, Farm Lighting
U. S. Light & Heat Corporation
Willard Storage Battery Co.

Batteries, Storage, Lighting, B23
*Electric Storage Battery Co.
*Prest-O-Lite Co., Inc.
*U. S. Light & Heat Corporation
*Westinghouse Union Battery Co.
*Willard Storage Battery Co.

Batteries, Storage, Starting and Lighting, B23
*Electric Storage Battery Co.
*Prest-O-Lite Co., Inc.
*U. S. Light & Heat Corporation
*Westinghouse Union Battery Co.
*Willard Storage Battery Co.

Battery-Boxes
Mullins Body Corporation

Bearings Babbitt and Aluminum
Bunting Brass & Bronze Co.
Franklin Die-Casting Corporation

Bearings, Babbitt and Bronze
Bunting Brass & Bronze Co.
Federal-Mogul Corporation
Milwaukee Die-Casting Co.
Mueller Brass Co.
Stewart Mfg. Corporation

Bearings, Babbitt Metal
General Die-Casting Co.
Milwaukee Die-Casting Co.

Bearings, Ball, Angular Contact Type, C33 to C33c
*Bearings Co. of America
*Fafnir Bearing Co.
*Gurney Ball Bearing Co.
*Marlin-Rockwell Corporation
*New Departure Mfg. Co.
*Strom Ball Bearing Mfg. Co.

Bearings, Ball, Annular, Extra Large, Light and Medium Series, C27 and C29
*Fafnir Bearing Co.
*Gurney Ball Bearing Co.
*Marlin-Rockwell Corporation
*Strom Ball Bearing Mfg. Co.

Bearings, Ball, Annular, Extra Small Series, C33
*Fafnir Bearing Co.
*New Departure Mfg. Co.
*Norma-Hoffmann Bearings Corporation
*Strom Ball Bearing Mfg. Co.

Bearings, Ball Annular, Light, Medium and Heavy Series, C26, C28 and C30
*Fafnir Bearing Co.
*Gurney Ball Bearing Co.
*New Departure Mfg. Co.
*Marlin-Rockwell Corporation
*Norma-Hoffmann Bearings Corporation
*Strom Ball Bearing Mfg. Co.
Torrington Co.

Bearings, Ball, Annular, Separable (Open) Type, C32
*Fafnir Bearing Co.
*New Departure Mfg. Co.
*Norma-Hoffmann Bearings Corporation

Bearings, Ball, Annular, Wide Type, C31
*Brown-Lipe Gear Co.
*Fafnir Bearing Co.
*New Departure Mfg. Co.
*Strom Ball Bearing Mfg. Co.

Bearings, Ball, Thrust, Single-Direction, Flat-Face Type, C35 and C36
*Bantam Ball Bearing Co.
*Bearings Co. of America
*Fafnir Bearing Co.
*Norma-Hoffmann Bearings Corporation
*Strom Ball Bearing Mfg. Co.

Bearings, Ball, Thrust, Single-Direction, Self-Aligning Type, C37 and C38
*Bantam Ball Bearing Co.
*Bearings Co. of America
*Fafnir Bearing Co.
*Norma-Hoffmann Bearings Corporation
*Strom Ball Bearing Mfg. Co.

Bearings, Ball, Thrust, Steering Knuckle Type, C34
*Bantam Ball Bearing Co.
*Bearings Co. of America
*Fafnir Bearing Co.
*Norma-Hoffmann Bearings Corporation
*Strom Ball Bearing Mfg. Co.

Bearings, Bronze
Bunting Brass & Bronze Co.
*Federal-Mogul Corporation
Mueller Brass Co.

Bearings, Die-Cast
General Die-Casting Co.

Bearings, Roller, Metric-Type, C43 and C44
*Bock Bearing Co.
*Hyatt Roller Bearing Co.
*Norma-Hoffmann Bearings Corporation
*Shafer Bearing Corporation

Bearings, Roller, Straight, Inch-Type
Hyatt Roller Bearing Co.
*Norma-Hoffmann Bearings Corporation

Bearings, Roller, Tapered, Inch-Type
Timken Roller Bearing Co.

Bearings, Thrust, Ball, Clutch Release Type, C39
*Bantam Ball Bearing Co.
*Bearings Co. of America
*Fafnir Bearing Co.
*Norma-Hoffmann Bearings Corporation

Bearings, Thrust, Tapered Roller
Timken Roller Bearing Co.

Belting, Tractor, E51
*Goodyear Tire & Rubber Co., Inc.
*Russell Mfg. Co.

Belts, 'V' Fan, A14a
*Gilmer Co., L. H.
*Goodyear Tire & Rubber Co., Inc.

Belts, Flat Fan, A14a
*Gilmer Co., L. H.
*Goodyear Tire & Rubber Co., Inc.
*Russell Mfg. Co.

Bindings
Carter Co., George R.

Blanks, Fibre Gear
Diamond State Fibre Co.

Blanks, Gear
Akron-Selle Co.
Bethlehem Steel Co.
Canton Drop Forging & Mfg. Co.
Central Steel Co.
Link-Belt Co.
Park Drop Forge Co.
Union Switch & Signal Co.

Blanks, Sprocket
Akron-Selle Co.

Blowpipes
Oxweld Acetylene Co.

Boards, Floor and Toe
Parish Mfg. Corporation

Bodies, Passenger Car
Baker R & L Co.
Mullins Body Corporation
Murray Body Corporation

Bodies, Steel
Mullins Body Corporation

Bolts, Carriage
Columbus Bolt Works Co.

Bolts, Connecting-Rod, A5
*Ferry Cap & Set Screw Co.
*National Acme Co.
*Steel Products Co.

Bolts, Eye
Williams & Co., J. H.

Bolts, Fender
Columbus Bolt Works Co.

Bolts, Hexagon Head, C2
*National Acme Co.

Bolts, King
Ferry Cap & Set Screw Co.
Steel Products Co.

Bolts, Spring-Center, H4
*National Acme Co.

Bolts, Spring Shackle
Steel Products Co.
Bowen Products Corporation
Ferry Cap & Set Screw Co.

Bolts, Step
Columbus Bolt Works Co.

Bolts, Tie-Rod
Ferry Cap & Set Screw Co.
Steel Products Co.

Brackets, Fender
Murray Mfg. Co., J. W.
Parish Mfg. Corporation
Smith Corporation, A. O.

Brackets, Running-Board, H23
Crosby Co.
Murray Mfg. Co., J. W.

Brake-Bands
Bossert Corporation
Diamond State Fibre Co.

Brake-Drums
Bethlehem Steel Co.
Bossert Corporation
Crosby Co.
Smith Corporation, A. O.

Brake-Hose Assemblies, Hydraulic
Hydraulic Brake Co.

Brake-Lining, C53
Johns-Manville, Inc.
*Russell Mfg. Co.

Brakes, Air
Bragg-Kliesrath Corporation
Westinghouse Air Brake Co.

Brakes, Hydraulic
Hydraulic Brake Co.

Brakes, Mechanical
Bendix Brake Co.

Brass Alloys, B106
*Dole Valve Co.

Breakers, Circuit
Dayton Engineering Laboratories Co.

Bronze Alloys, D108
*Dole Valve Co.

Buckram, Leather
Carter Co., George R.

Bulbs, Incandescent Lamp, B5
*Brown Mfg. Co., Jno. W.

Bumpers, Passenger Car, C55
*Biflex Corporation
*C. G. Spring & Bumper Co.
*Stewart-Warner Speedometer Corporation

Bushings, Babbitt
Federal-Mogul Corporation

Bushings, Bronze
Bunting Brass & Bronze Co.
Danly Machine Specialties, Inc.
Dole Valve Co.
Federal-Mogul Corporation
*Mueller Brass Co.

Bushings, Composition
Diamond State Fibre Co.
Formica Insulation Co.

Cabs, Motor Truck, L52
Murray Body Corporation

Cable, Insulated, B33
Bosch Magneto Co., Inc., Robert
General Electric Co.
Kerite Insulated Wire & Cable Co., Inc.
Western Electric Co.

Cables, Starting-Motor, B-21
Western Electric Co.

Camshafts
Canton Drop Forging & Mfg. Co.
Park Drop Forge Co.
Wyman-Gordon Co.

Caps, Hub
Bossert Corporation
Crosby Co.

Caps, Radiator, C58a
General Die-Casting Co.
*Stewart-Warner Speedometer Corporation

Caps, Tank, C58a
Akron-Selle Co.
General Die-Casting Co.
Stewart-Warner Speedometer Corporation

Carbureter Controls, Automatic
*Dole Valve Co.

Carbureters, Cast Iron, A8
*Byrne, Kingston & Co.
*Stewart-Warner Speedometer Corporation

Carbureters, A8
*Byrne, Kingston & Co.
*Stewart-Warner Speedometer Corporation
Stromberg Motor Devices Co.

Casings, Radiator
Bossert Corporation
Mullins Body Corporation

Castings, Alloy
General Die-Casting Co.

Castings, Aluminum, D104
*Franklin Die-Casting Corporation
General Die-Casting Co.
Milwaukee Die-Casting Co.
Scovill Mfg. Co.

Castings, Babbitt Metal
General Die-Casting Co.

Castings, Brass, D106
*Franklin Die-Casting Co.
Milwaukee Die-Casting Co.
*Mueller Brass Co.
*Scovill Mfg. Co.
Stewart Mfg. Corporation

Castings, Bronze, D108
Franklin Die-Casting Corporation
General Die-Casting Co.
Milwaukee Die-Casting Co.
*Mueller Brass Co.
*Scovill Mfg. Co.

Castings, Die**
Franklin Die-Casting Corporation
General Die-Casting Co.
Milwaukee Die-Casting Co.
*Stewart Mfg. Corporation

Castings, Grey Iron
Link-Belt Co.

Castings, Malleable Iron, D9
*American Malleable Castings Association
*Eberhard Mfg. Co.
*Link-Belt Co.

(Continued on page 108)

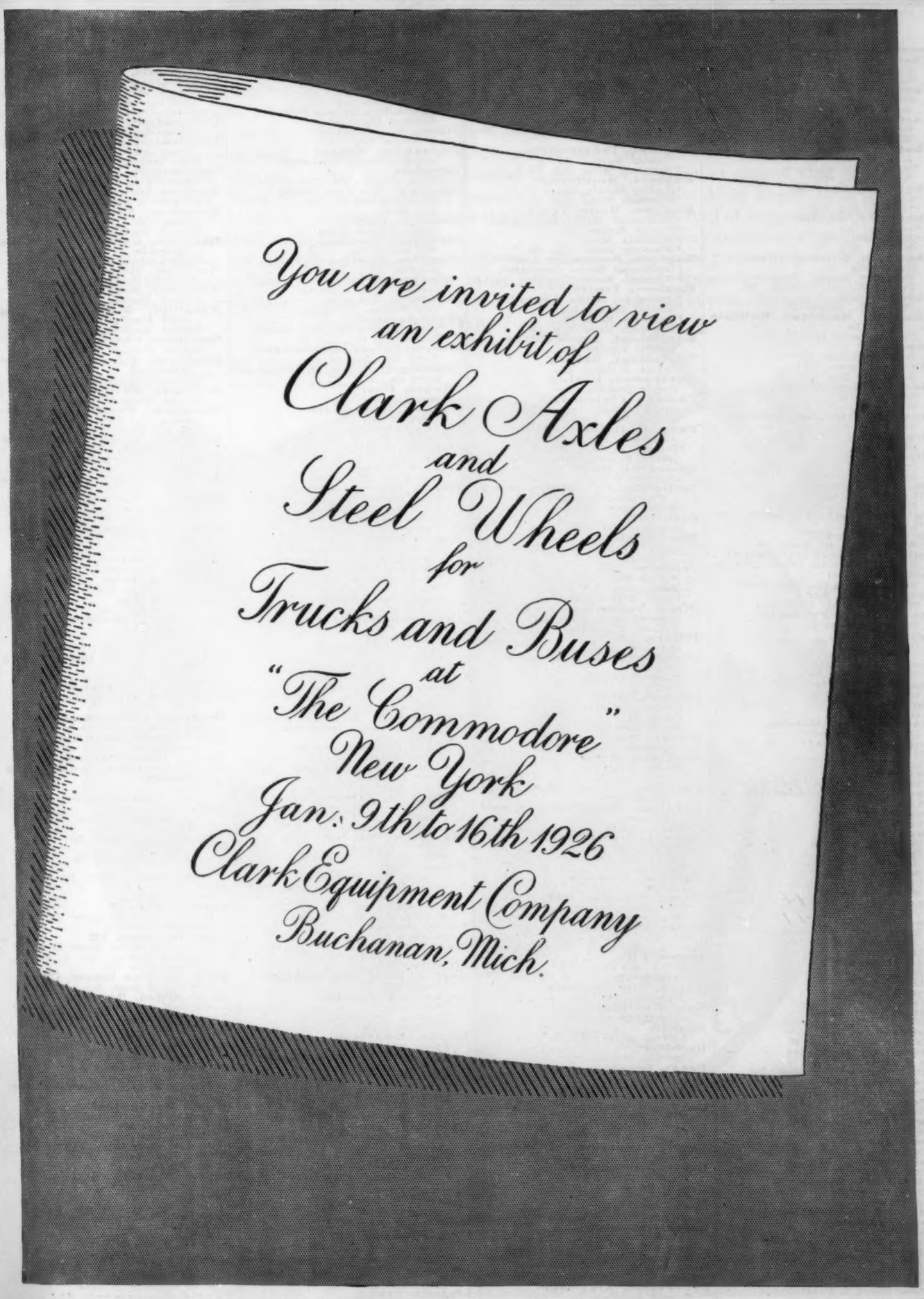
EXPLANATION OF SYMBOLS

Parts and materials followed by key numbers have been standardized by the S. A. E. The numbers refer to S. A. E. HANDBOOK data sheets on which each standard is published.

*Companies whose names are preceded by an asterisk supply the parts or materials under which the company is listed as conforming with the S. A. E. Standard referred to.

**Parts and materials followed by two asterisks indicate that two or more S. A. E. Standards are applicable. Information as to standards incorporated should be obtained from the manufacturer.

The adress of companies listed in this index can be obtained from their current advertisements indexed on page 112.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and
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for
Trucks and Buses
at
"The Commodore"
New York
Jan. 9th to 16th 1926
Clark Equipment Company
Buchanan, Mich.

INDEX TO ADVERTISERS' PRODUCTS

(*Concluded on page* 110)

INDEX TO ADVERTISERS' PRODUCTS

INDEX TO ADVERTISERS

An index to advertisers' products is given on pages 106, 108 and 110.

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